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Improved 220-inch Post Radial Drill.

The accompanying perspective view shows what is claimed to be the largest post radial drill built in this country. It is designed to drill holes in the center of an area 220 inches in diameter, and when the spindle is at its extreme height it will take between the bed and spindle a height of 8 feet.

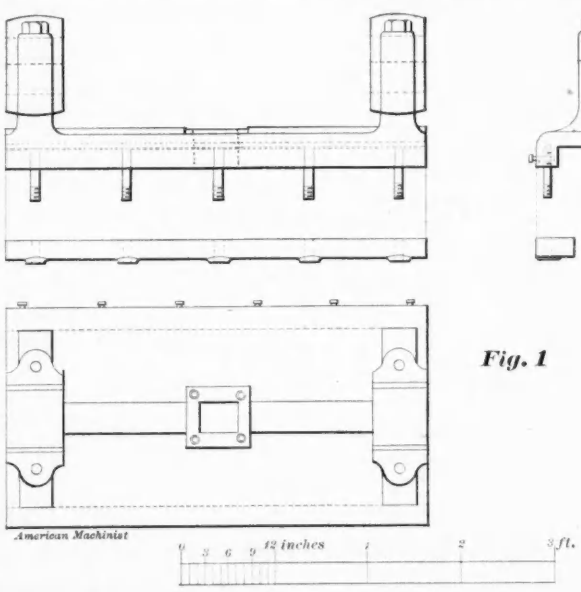


Fig. 1

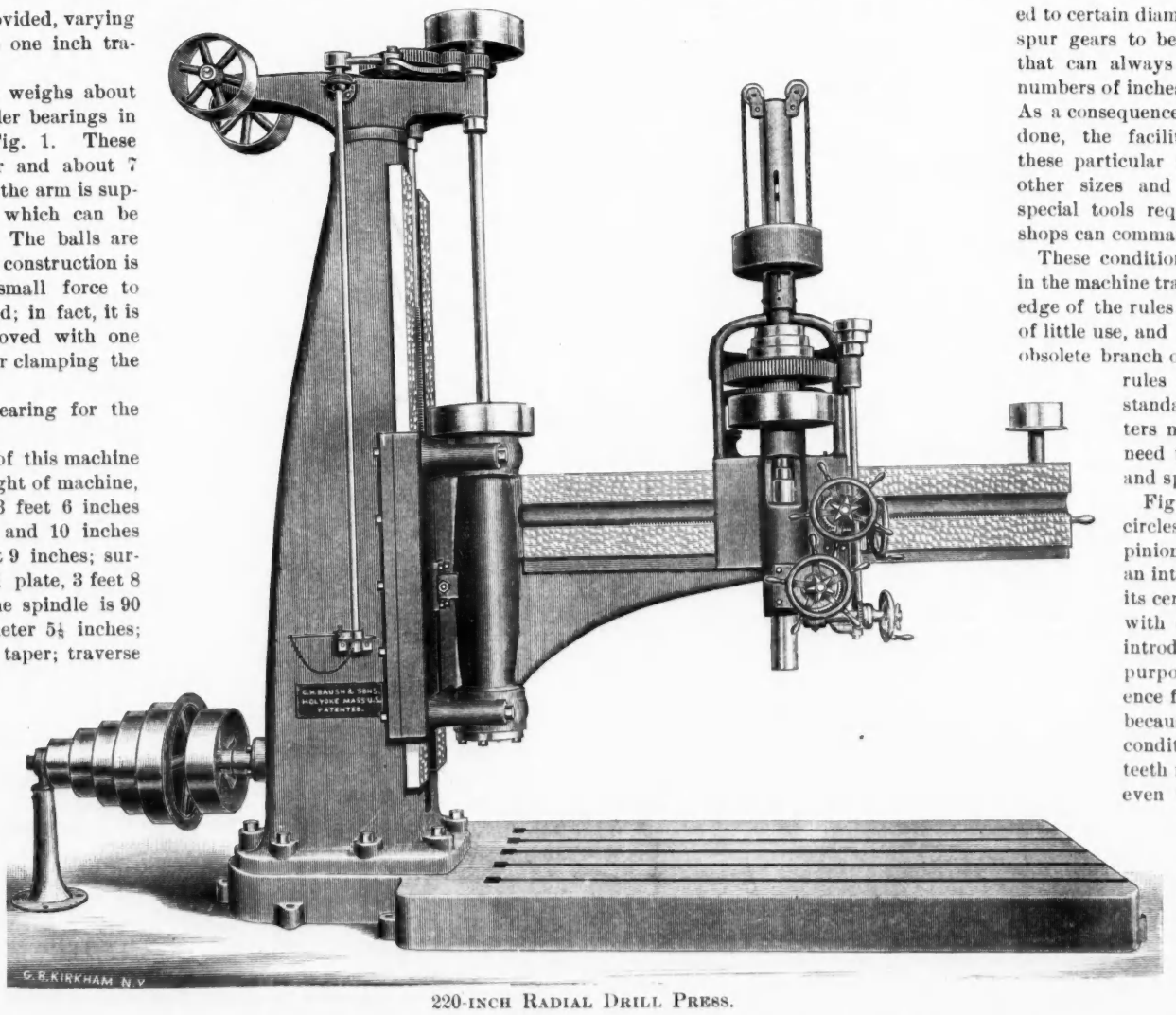
Back gears are located on the spindle and are proportioned 10 to 1. There are ten different speeds, varying from 285 to 5 revolutions per minute.

Three different feeds are provided, varying from 135 to 50 revolutions to one inch traverse of spindle.

The swinging arm, which weighs about 4 tons, is supported by roller bearings in the saddle, as shown in Fig. 1. These rollers are ½ inch diameter and about 7 inches long. The bottom of the arm is supported by a ball bearing which can be readily adjusted vertically. The balls are ¾ inch diameter. The whole construction is such as to require but a small force to swing this heavy arm around; in fact, it is claimed that it can be moved with one finger. Provision is made for clamping the arm rigidly to the post.

Fig. 3 shows the ball bearing for the hoist screw.

The principal dimensions of this machine are as follows: Extreme height of machine, 18 feet; the bed plate is 13 feet 6 inches long, 5 feet 6 inches wide, and 10 inches thick; height of post, 11 feet 9 inches; surface of post resting on bed plate, 3 feet 8 inches by 2 feet 8 inches; the spindle is 90 inches long, its largest diameter 5⅛ inches; it is made to fit No. 6 Morse taper; traverse of spindle, 22½ inches; the cone pulleys have five steps for a 5-inch belt. The machine weighs a little over 24,000 pounds. It is built by C. H. Baush & Sons, Holyoke, Mass.



220-INCH RADIAL DRILL PRESS.

It is gratifying to know that recently the attendance at the World's Fair has considerably increased and that it is not true as many were asserting that the people were feeling too poor and too uncertain of the future to admit of their spending the necessary money to get there. Though it is true that we are passing through a period of commercial depression, there are strong grounds for the belief that times are soon to improve.

Annular and Differential Gearing.

BY S. W. BALCH.

Gearing is a subject about which so much has been written, that an explanation is in order before adding further to its literature. It is a fascinating study and one already seemingly exhausted in its practical bearings by writers well able to present it.

However, while theory has given us all the conceivable forms of teeth and discussed their action, and the practical man has exhausted language in telling about their respective merits, there is one direction in which the mathematical discussions have fallen short—at least with respect to peculiar forms, such as differential or internal and spiral gearing. In discussing the rules for the design of these classes of gearing the customary shop facilities have not been sufficiently kept in view. Owing to the patent monopoly enjoyed by Brown & Sharpe in the manufacture of gear cutters they have had the opportunity of determining and making these facilities uniform for the whole country. It is needless for me to add that they have made wise use of their opportunity. Under their direction two classes of tooth curves have been chosen from the innumerable possible forms, and these again have been limited to certain diametral pitches which enable spur gears to be designed with diameters that can always be designated by whole numbers of inches and convenient fractions. As a consequence, wherever gear cutting is done, the facilities exist for fashioning these particular sizes with accuracy, and other sizes and shapes only by making special tools requiring skill that but few shops can command.

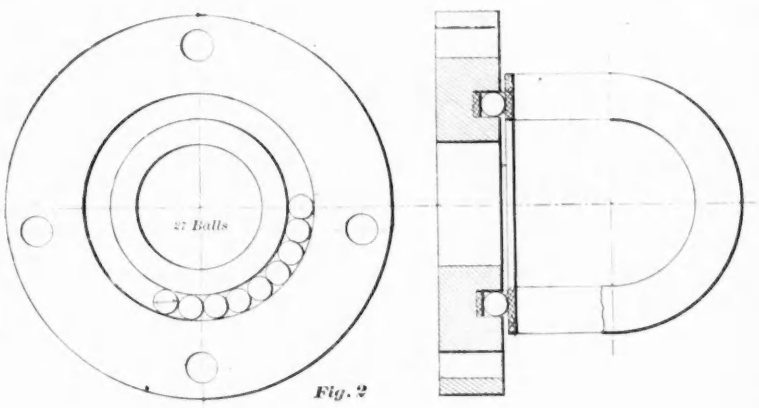


Fig. 2

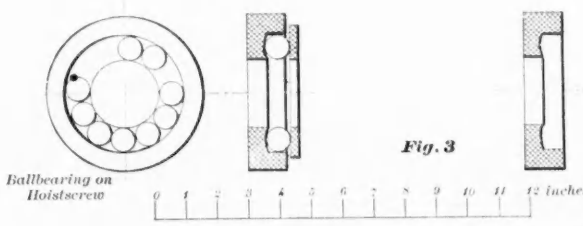


Fig. 3

These conditions, which have grown up in the machine trade, have rendered a knowledge of the rules for designing tooth curves of little use, and have replaced this almost obsolete branch of the science with simple rules for sizing gears so that standard Brown & Sharpe cutters may be used. These rules need to be extended to internal and spiral gears.

Fig. 1 (page 2) shows the pitch circles and a few teeth of a pinion with its center at *P* and an internal or annular gear with its center at *I*. They are shown with cycloid teeth. I have not introduced cycloid teeth for the purpose of showing any preference for this form of curve, but because the discussion of the conditions under which such teeth may be used is necessary, even though involute teeth are to be employed.

The cycloid curves are generated in the same way as for ordinary spur gears. A describing circle *A* gives the curve for the faces of the internal gear teeth and the flanks of the pinion teeth with which they engage, and a second describing circle *B* serves to trace the faces of the pinion teeth and the flanks of the gear teeth. These describing circles may be the same or of different sizes as desired.

It is possible to describe tooth curves

with the circle D, which is intermediate in diameter between the pinion and gear. It would, however, describe the faces of both pinion and gear teeth, instead of the faces of one and the flanks of the other. It is obvious that the same circle should be used in describing both pinion teeth and gear teeth, for, if the pinion teeth should be generated by a smaller circle, their faces would contact only at the pitch line on the line of centers of the wheels and would separate at once on moving away from this line. If, on the other hand, the describing circle enclosing the pinion should be larger than that for the faces of the internal gear, an interference will result which will make it impossible to mesh the two together.

It is a fact worth noticing, the geometrical reasons for which I will not enter into here, that the tooth curves generated by such an intermediate describing circle are identical with those which a small describing circle inscribed between it and the pitch line would generate. Thus the curve given to the tooth faces of the internal gear by the circle A is the same as that generated by the circle D; and likewise the circle B generates the same face curves as D for the pinion. In selecting describing circles for teeth in inside gears it will therefore be necessary to keep in mind that they give the face curves of intermediate circles as well. From these considerations it follows that the sum of the diameters of the describing circles for faces and flanks should not exceed the difference in the pitch diameters of the pinion and its internal gear. The sum may be equal to this difference or it may be less; if it is equal the faces of the teeth of each wheel will drive the faces as well as the flanks of the teeth of the other wheel. The teeth will therefore contact with each other at two points at the same time. As the gears revolve from left to right with the pinion driving, one of these points of contact will travel along the line of the intermediate describing circle from c to c', and the other along the two small describing circles from a to b.

Cycloid tooth curves for interchangeable gears are formed with describing circles of about $\frac{5}{8}$ the pitch diameter of the smallest gear of the series. As this is usually $\frac{5}{8}$ of a ten-toothed gear it follows that the describing circle employed will about correspond to the pitch circle for six teeth. To admit two such circles between the pitch circles of the pinion and internal gear these latter will have to differ by 12 teeth. These considerations lead to this practical rule.

The number of teeth in the internal gear should exceed the number in the pinion by 12 or more, if the teeth are of the customary proportions and curvature used in interchangeable gearing.

Very often a less difference is desirable, and the teeth may be modified in several ways to make this possible.

First.—The tooth curves resulting from smaller describing circles may be employed. These will give teeth which are more rounding and narrower at their tops, and therefore not as desirable as the regular forms.

Second.—The tips of the teeth may be rounded until they clear. This is a cut-and-try method which aims at modifying the teeth to such outlines as smaller describing circles would give. If the tips of the teeth are much rounded they become useless for driving and may be removed so that the spaces into which they fit need not be cut so deep. This will result in teeth so short and stumpy that their number might better be increased; in other words the rule above laid down might as well be followed and a pitch selected which will be sufficiently fine to give the required difference of 12 teeth.

Third.—One of the describing circles may be omitted and one only used which may be equal to the difference between the pitch circles. This will permit the meshing of gears differing by six teeth. The effect of omitting one of the describing circles, as for example circle A, is to cut off the teeth of the internal gear at the pitch line and to fill up the spaces between the teeth of the pinion to the pitch line. Thus the pinion teeth will have no flanks and the gear teeth will have no faces. This is in effect shortening the teeth so that they might better be twice as numerous. This method of modifying the tooth outlines makes the teeth of one of the wheels further apart than the teeth of the other wheel, except at their pitch lines, but this difference benefits rather than impairs the action, if the one having the coarser teeth is always the driver.

These several considerations lead therefore to the general conclusion that it will usually prove inexpedient to put wheels in inside gears that differ by much less than 12 teeth, since in the ordinary course of design the diameters of the pitch circles are first chosen, and the ratio of speed is the only other imperative condition imposed. The difficulties can ordinarily be best set aside by selecting a pitch sufficiently fine to give the required difference in the number of teeth.

Before leaving the subject of describing circles one other precaution is to be observed, if the pinion is quite small with respect to the gear. This is that the radius of the intermediate describing circle should not be less than the line of centers. If it is, its complementary circle A will be larger than the pitch circle of the pinion, and two intermediate describing circles will result. If regular tooth forms are adopted this will be avoided, if the pinion does not have less than six teeth.

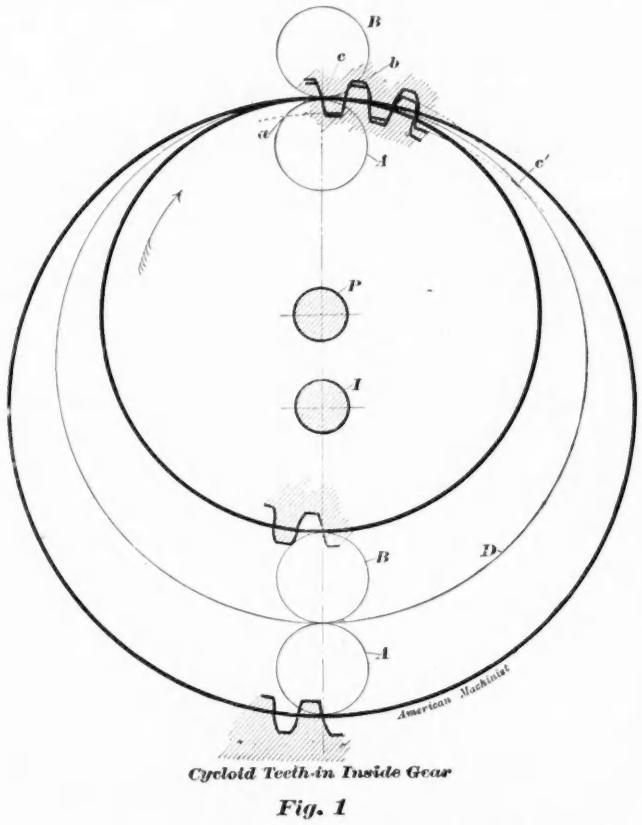
If a regular diametral pitch and standard tooth forms are determined on, the necessary instructions to the workman become quite simple. The diameter to which the internal gear blank is to be bored is calculated by subtracting 2 from the number of teeth, and dividing the remainder by the diametral pitch. This is very similar to the rule for finding the outside diameter of the spur gears, and differs from it in that 2 is subtracted instead of added to the number of teeth before dividing by the pitch.

The tooth outlines are the match of a spur gear of the same number of teeth and diametral pitch, so that the spur gear will fit the internal gear as a punch fits its die. There should be this difference, however, the teeth of each should fail to bottom in the tooth spaces of the other by the customary clearance. This clearance is one-tenth the thickness of the tooth, and may be calculated by dividing 157 thousandths by the diametral pitch.

As it is not practicable to use rotary mills in cutting internal gear blanks, this work is usually performed on a slotting machine. A cutting tool must therefore be fashioned to the proper shape to cut the spaces. This may be done by copying the tooth of a spur gear of the same size and pitch. In copying this the point of the tool should be left projecting beyond the tip of the tooth by the customary clearance.

If special accuracy is desired the slotting tool may be shaped in a more certain manner by clamping it to the face-plate of a dividing head, and cutting each side with the milling cutter designed for the corresponding spur gear. In fastening the steel for the slotting tool to the dividing head it should project beyond the center the distance found by dividing half the number of teeth plus 1.157 by the diametral pitch. This distance is the radius of the corresponding spur gear blank plus the clearance. The mill should be sunk below the top of the slotting tool by this clearance plus the customary depth of space. This distance equals 2 314 divided by the diametral pitch.

The involute curve has the same merits over the cycloid for internal that it has for spur gearing, and if the above precautions are observed involute may generally be substituted for cycloid cutters with good results. Interference between the faces of the teeth is to be looked for and avoided as in the case of cycloid teeth. This can be determined in the design by working out the curves of the faces for both systems and observing if the involute curve falls within the cycloid curve. This will be the case if the tops of the teeth are no broader than the cycloid curves would leave them. If they should be, it will be necessary to chamfer the corners of the teeth to the cycloid form; adopt an involute with more obliquity, or reduce the height of the teeth.



Cycloid Teeth in Inside Gear

Fig. 1

INVOLUTE TEETH IN INSIDE GEAR.

The involute teeth shown have been carefully drawn in Fig. 2 so as to illustrate the peculiar way in which they engage. The sides of the pinion teeth are convex and of the internal gear concave. The curvature of the latter is very slightly less, so that while the teeth of the two wheels appear to coincide all along their faces, they are, in theory, tangent to each other at a point. This theoretical point of contact begins for each tooth as it reaches i and ceases at i'. It follows along the straight line between these points. For this short distance that the teeth are in contact, the pitch circles of the two wheels coincide so nearly, and consequently the motion of the teeth of one wheel in or out of the other is so slight that they may be said to engage without slip and are therefore frictionless.

If the reader will observe carefully how the tooth curves lie with respect to each other at each successive position he will see several other interesting features of this form of gearing. As the teeth of each

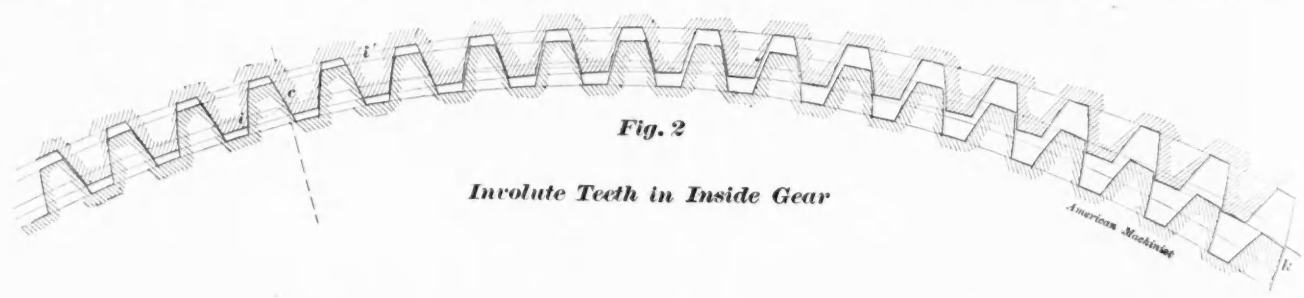


Fig. 2

Involute Teeth in Inside Gear

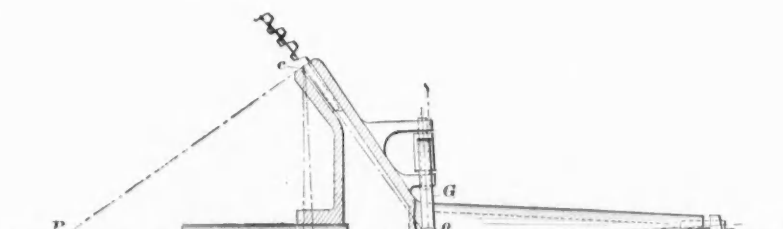


Fig. 3

ANNULAR AND DIFFERENTIAL GEARING.—SEE PAGE 1.

wheel approach from the left to the point i, where they engage, they enter each other's spaces without touching until they are almost fully in mesh and then come together without appreciable slip, likewise on passing i' the driving faces first separate and then the teeth pull out of mesh, the faces getting further apart as the teeth roll apart. This latter, however, occurs only for a short distance. When the teeth whose action we have been studying, reach a point about 30 degrees from the line of centers when they were in engagement, the working faces again begin to approach, and when they have been carried about 40 degrees from the line of centers they will collide at k, unless the proper precautions are observed. The teeth shown are of wheels having 116 and 105 teeth. The difference is only 11 and regular teeth are therefore not practicable. Some provision was therefore necessary to prevent a collision of the teeth at k. This consisted in shortening the height of the teeth of the internal gear inside the pitch line so that the teeth of the wheels will be out of mesh on passing this point where their collision would otherwise begin.

DIFFERENTIAL GEARING.

Internal gearing is particularly valuable when employed in differential action. This is a mechanical movement in which one of the wheels is mounted on a crank so that its center can move in a circle about the center of the other wheel. Means are added to the device which restr in the wheel on the

crank from turning over and confine it to the revolution of the crank.

The ratio of the number of teeth in the revolving wheel compared with the difference between the two, will represent the ratio between the revolving wheel and the crank-shaft by which the other is carried. If the wheels above discussed are employed the ratio of speed will be as 11 to 105, or nearly 10 times. The advantage in accomplishing the change of speed with such an arrangement, as compared with ordinary spur gearing, lies in the almost entire absence of friction and consequent wear of the teeth.

But for the limitation that the difference between the wheels must not be too small, the possible ratio of speed might be increased almost indefinitely, and one pair of differential gears made to do the service of a whole train of wheels. Fortunately, however, if the problem is properly worked out with bevel gears this limitation may be completely set aside, and external and internal bevel gears, differing by but a single tooth if need be, made to mesh perfectly with each other.

DIFFERENTIAL BEVEL GEARS.

In Fig. 3 the gears have 60 and 62 teeth, and therefore give a ratio of speed of 30 times. The internal bevel is supported from frame work, which is not shown, through the gimbal ring *G*. This ring while restraining the gear from revolving with its mate leaves it free to shift the point where it meshes with the other wheel. An arm on the gear is carried by the small crank at the right. This keeps the axis of the internally toothed gear inclined, and its teeth always in mesh with the other gear. The action of the mechanism when in motion is peculiar. The internally toothed gear guided by the gimbal and crank has a wabbling movement, and the place of meshing shifts rapidly around the gears—so rapidly, in fact, that the cycle is completed while the rotary gear is turning through the space of two teeth—two being the difference in the numbers of the two gears. In order to find out if the teeth of these bevel gears will mesh properly, let us proceed to lay out on a flat surface the traces of them at their large ends. This can be done in the usual way. Two cones are conceived to surround the peripheries of the two gears; that of the smaller gear having its vertex at *P*, and of the internally toothed gear with its vertex at *I*. When these cones are unwrapped and laid flat with the traces of the gear teeth on them, these teeth will lie in arcs of circles and the radii of their pitch circles will be respectively *P c* and *I c*. If the teeth are repeated around their developed pitch circles one will be found to contain 105 and the other 116. As this is the identical lay-out drawn above to a larger scale, and found to be free from interference, it must also be operative when it is applied to bevels in inside gear.

The practical operation of laying out a pair of differential bevel gears is the converse of the above analysis. The designer will naturally wish first to select such numbers of teeth as will give the required differential action. Conjointly with this the pitch will be settled on which will make the wheels of a convenient diameter and the teeth of suitable strength.

The next step in the solution of the problem is to determine on two spur wheels in inside gear to be of the same pitch, but each to have more teeth than was settled upon for the bevels. The above noted precautions as to spur wheels are, of course, to be observed; but this limitation will give no trouble since the sizes to be chosen may be almost anything in excess of the bevels. These having been chosen, their radii are laid off on the same line at *P c* and *I c*. On these distances as hypothenuses the right-angled triangles *P c p* and *I c i* are constructed; *c p* and *c i* being the radii of the bevels. *P p* and *I i* will be their axes. These axes are then prolonged through their point of intersection *o*, and the teeth converging from *c* towards *o* are laid out symmetrically about these axes as shown. The other details of construction will be clear from the illustration.

The proportions here illustrated are those which have been adopted in applying this mechanism to the mowing machine. In the mowing machine it takes the place of three gears and three pinions, and by its freedom from friction makes the draught far lighter; so much so, in fact, that I have been able with one horse to cut an equal width of swath with a two-horse machine constructed with ordinary gearing. The gain was so marked when experimenting in salt grass along with a two-horse machine of a well known maker, that while two horses gathered lather through the exertion of drawing the ordinary geared machine, one horse would pull the wabble gear machine with apparent ease.

In applying the wabble gear to the mowing machine a slight departure from the form illustrated is necessary in order that the main shaft or axle may be extended past it to the right, so that both ends may be supported and driven by the driving wheels. This modification consists in deflecting the arm of the wabble gear slightly to one side and setting the crank shaft to one side of the center line sufficiently for its crank to swing clear of the axle.

The wabble gear mechanism imposes on the designer no limitations as to ratio of speed. The ratio may be fixed as readily at 10 or at 50, and the modification necessary in the design to adapt it to either will involve no material change in size or complexity of mechanism. Where it is used no provision need be made for a change of speed elsewhere in the machinery. In the mowing machine as usually geared, the designer is obliged to use small driving wheels which revolve more rapidly than larger ones, in order to avoid excessive gearing. As a consequence, such machines are usually provided with small wheels although no vehicle is more in need of larger ones for smooth running.

The wabble gear as here shown is subject to a slight irregularity of movement, owing to the oscillation of the upper and lower bearings of the gimbal towards the point where the gears mesh. The leverage varies about 7 per cent. and causes the velocity of the small crank-shaft to vary by this amount twice in each revolution. There are ways by which this irregularity of the velocity may be eliminated if the conditions make it desirable.

There is said to be quite a decided improvement in business in both France and Germany.

The consumption of water in London is 37.74 gallons (English) per head per day.

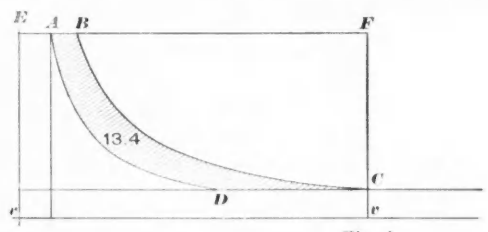


Fig. 1

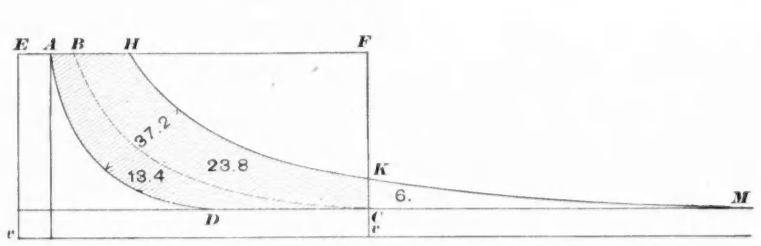


Fig. 2

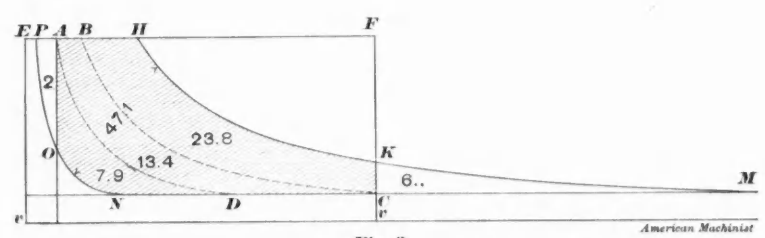


Fig. 3

COMPRESSION AS A FACTOR IN STEAM ENGINE ECONOMY.

Compression as a Factor in Steam Engine Economy.*

BY FRANK H. BALL, NEW YORK CITY.

This paper is intended, first, to attack the theory that the most economical compression curve is one which fills the clearance space to initial pressure; second, to point out certain relations which the writer thinks should exist between the expansion curve and the compression curve, so that for any given point of cut-off the point of exhaust closure corresponding in efficiency may be known by inference.

Let Figs. 1, 2 and 3 represent theoretical diagrams, produced by Mariotte's law, which is considered sufficiently accurate in this case, as the diagrams will not be used for accurate measurements, but simply to illustrate a theory.

Let these diagrams be supposed to have been produced by an engine with 10 per cent. clearance, represented by the distance from *A* to *E*, and the vacuum line being *V V*.

In the diagram represented by Fig. 1, cut-off takes place at about $\frac{1}{15}$ stroke, and expansion is carried to the atmospheric line or the line of back pressure, thus preventing any waste by free expansion when exhaust takes place.

Compression is also made to just fill the clearance space to boiler pressure, leaving no waste room to be filled from the boiler.

Disregarding engine friction, and considering only the work indicated in the cylinder, this diagram would correspond to the highest efficiency of this engine if there were no loss by cylinder condensation. But it is well known that a considerably later cut-off than $\frac{1}{15}$ stroke is more economical, notwithstanding the consequent waste by free expansion at exhaust, and the reason must be found in the fact that cylinder condensation is so nearly a fixed amount per stroke, that by increasing the power developed at each stroke the loss becomes relatively smaller.

Referring to Fig. 2, suppose the diagram *A H K C D* to have been produced by the same engine cutting off at $\frac{1}{4}$ stroke, for the purpose of illustration will be assumed to be the most economical point of cut-off, although the logic of what is to follow would apply equally well to any other point of cut off.

Comparing this diagram with Fig. 1, we find that by the later cut-off the mean effective pressure has been increased from 13.4 pounds at $\frac{1}{15}$ cut-off to 37.2 pounds at $\frac{1}{4}$ cut-off, and the power thereby developed being nearly three times as great, the loss per horse-power by cylinder condensation has been greatly reduced, notwithstanding the considerable waste at exhaust due to throwing away steam only partially expanded.

Now if it be true that starting with the theoretically perfect diagram *A B C D*, it is economy to increase its area along the expansion curve up to a point where a considerable waste by free expansion occurs at exhaust, it must follow that it will be economy to add something to the area of the diagram along the compression curve also, and if *B* is not the most economical point of cut-off, it may be safely assumed that the point of exhaust closure *D* is equally faulty.

As before stated, one of the objects of this paper is to point out what seems to the writer a logical method of determining the compression curve which shall correspond in economy of steam with any given expansion curve.

Referring again to Fig. 2, suppose the expansion curve be continued from *K* to *M*, where it intersects the atmospheric line.*

The useful work added to the diagram *A B C D* by changing the point of cut-off from *B* to *H*, is represented by the area of the diagram *H K C B*, amounting to 23.8 pounds M. E. P., and the work thrown away by free expansion at exhaust is represented by the area of the diagram *K M C*, which measures 6 pounds M. E. P.

With points of cut-off later than *H*, the curve *K M* increases rapidly in length by the removal of *M* along the atmospheric line, and the curve *H K* shortens by approaching the angle *F*, so that the area of the diagram of waste *K M C* increases very rapidly compared with the increase of the useful diagram *B H K C*.

The writer believes that what is true in regard to the expansion curve is equally true of the compression curve.

Referring to Fig. 3, if instead of the compression curve *D A*, the curve *N O* be substituted, the total area of effective diagram *A H K C D* will have been increased by the area of *A D N O*, equal to 7.9 pounds M. E. P., so that the original diagram *A B C D*, with a M. E. P. of 13.4, has been increased by 23.8 pounds M. E. P. along the expansion curve, and 7.9 M. E. P. along the compression curve.

The waste occasioned by the small compression *N O* is due to free expansion of the steam from the boiler in entering the clearance space, and is measured by the area of the diagram *P A O*, because the steam shut in by exhaust closure at *N*, and compressed to *O*, would, if compressed to boiler pressure, fill the clearance space only from *E* to *P*, and the space from *P* to *A* must be filled from the boiler.

Suppose this to have been done, and the admission valve to be closed at *A*. As the piston advances *A D* will be the expansion curve, and with *N O P* will form the diagram *A D N O P*.

Of this diagram the area of *A D N O* is useful work on the piston, and *P A O* is free expansion in the clearance space.

The area of this diagram *P A O* bears about the same relation to the useful diagram *A D N O* that the diagram of waste *K M C* bears to *B H K C*, and hence it is not unreasonable to suppose that if the most economical point of cut-off is at *H*, the curve *N O* will correspond to the highest economy of the engine, or at least will correspond to the efficiency of cutting off at *H*, because in both cases the useful work added along the respective curves is attended with about the same proportionate loss by free expansion.

Carefully conducted tests might develop the necessity of some slight modification of this theory, but in the absence of such data the writer will venture to suggest, in accordance with the foregoing, a general law

*Presented at the Mechanical Engineering Section B of the World's Engineering Congress.

*The diagram under consideration being a theoretic diagram, no distinction is made between the atmospheric line and the line of back pressure. With actual diagrams, whether exhausting into atmosphere or into vacuum, the continuation of the back pressure line parallel to *V V* should be substituted for the atmospheric line, both in the construction of the theoretically perfect diagram *A B C D* and also in locating the point *M*.

for approximating the point of exhaust closure which shall correspond in economy of steam with any given point of cut off.

This law may be stated as follows:

If in a given diagram any free expansion takes place at the terminal pressure, then compression should not rise to initial pressure, but the compression curve should be removed from the curve of full compression* a sufficient distance, so that the useful work thereby added to the diagram shall be accompanied with the same proportionate loss by free expansion that is found to accompany the work that has been added to the full expansion curve.†

In applying this law to the study of actual diagrams, first construct the full expansion curve as *B C*, Fig. 1. This is best done by tracing it backward from *C*. Next construct the full compression curve as *D A*, beginning for convenience at *A*. This will give the theoretically perfect diagram *A B C D*, located with proper relation to the actual diagram for the purpose of comparison.

Next continue the line of back pressure parallel to *V V* a sufficient distance to intersect the continuation of the actual expansion curve as from *K* to *M*, Fig. 3.

Having done this the diagrams *B H K C B* and *K M C* may each be measured and the ratio of their respective areas determined.

The compression curve *N O P* must then be so located that this ratio will apply to the respective areas of *A D N O* and *P A O*.

With this compression curve *N O*, located as described, we are ready to make comparison with the actual compression curve of the diagram under consideration.

In accordance with this law it might also be said that whenever the area of any diagram exceeds the area of the theoretically perfect diagram *A B C D*, Fig. 1, then this excess of area should be found distributed along the expansion and compression curves in the proportions indicated by this law, and it necessarily follows that a fixed compression will therefore not give as high economy of steam under varying loads as a varying compression, and that the highest economy might be expected when both the point of cut-off and of exhaust closure vary in such a manner that the relation of the areas added along the expansion and compression curves of *A B C D* shall at all times conform to this law.

To further illustrate this subject a series of five theoretic diagrams, Figs. 4, 5, 6, 7 and 8, are herewith submitted, in which various points of cut-off are selected between $\frac{1}{15}$ and $\frac{1}{4}$ stroke, and compression curves corresponding to such expansion curves are shown.

From measurement of these diagrams various curves are constructed on a chart shown in Fig. 9.

Referring to this series of diagrams the distance from *A* to *F* in each is made to represent the piston travel, and *A E* the clearance. The atmospheric line is *C D* and the vacuum *V V*.

In each of the diagrams of the series, except Fig. 4, a loss by free expansion occurs, and all, including Fig. 4, are accompanied by a loss due to cylinder condensation which does not appear in the diagram.

This cylinder condensation is the difference between the steam accounted for by the indicator and that actually used by the engine, and may be expressed in pounds of feed-water or steam, or in area of diagram, or mean effective pressure.

The latter method will be adopted in this investigation.

Thus in Fig. 4, with a M. E. P. of 13.4 pounds, if the indicator only accounts for $\frac{4}{5}$ of the steam the cylinder condensation may be expressed in pounds M. E. P. by $\frac{13.4}{4} = 3.3$ M. E. P.

With this method of measurement the whole area of the diagram must be used to express the steam accounted for by the indicator, and if it extends beyond the limit of piston travel, as in Figs. 5, 6, 7 and 8, it must be reduced to M. E. P. for the piston travel. Thus in Fig. 5 the M. E. P. of the useful diagram is 8.4 + 13.4 + 3.6 = 25.4, and the diagram of free expansion or waste .4 + 1 = 1.4 M. E. P.

The total M. E. P. which may be used as representing the steam accounted for by the indicator is therefore 25.4 + 1.4 = 26.8.

In all these diagrams the areas inclosed by heavy lines are indicated by figures which express the pounds M. E. P. in each case.

With the series thus arranged any desired combination of the expansion and compression curves may be made.

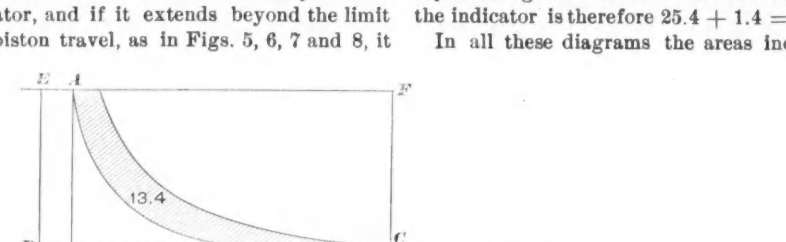


Fig. 4

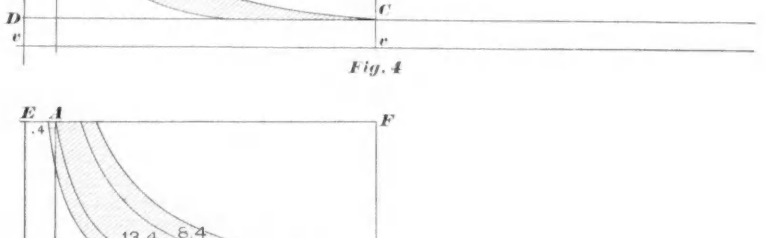


Fig. 5

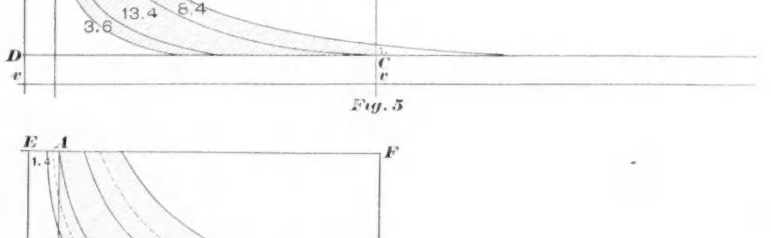


Fig. 6

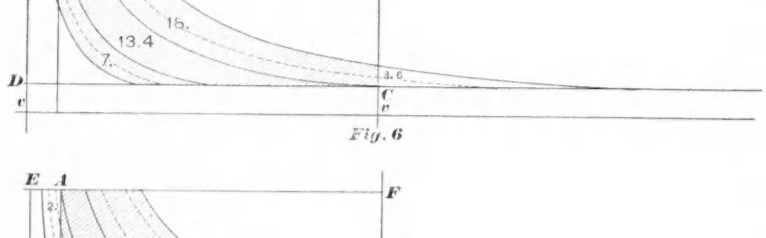


Fig. 7

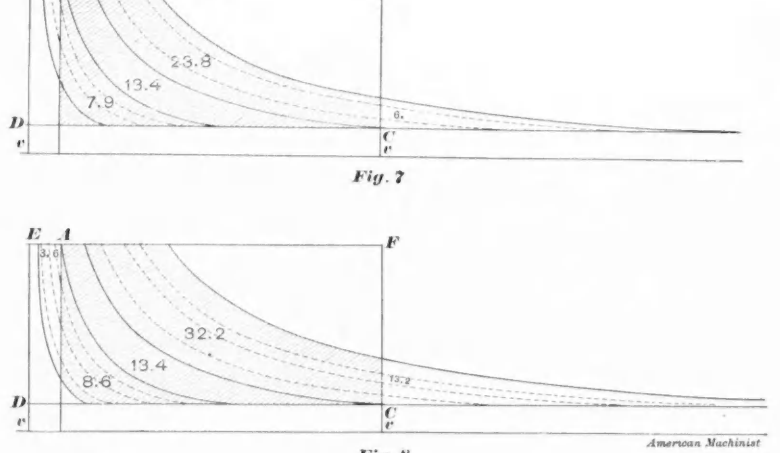


Fig. 8

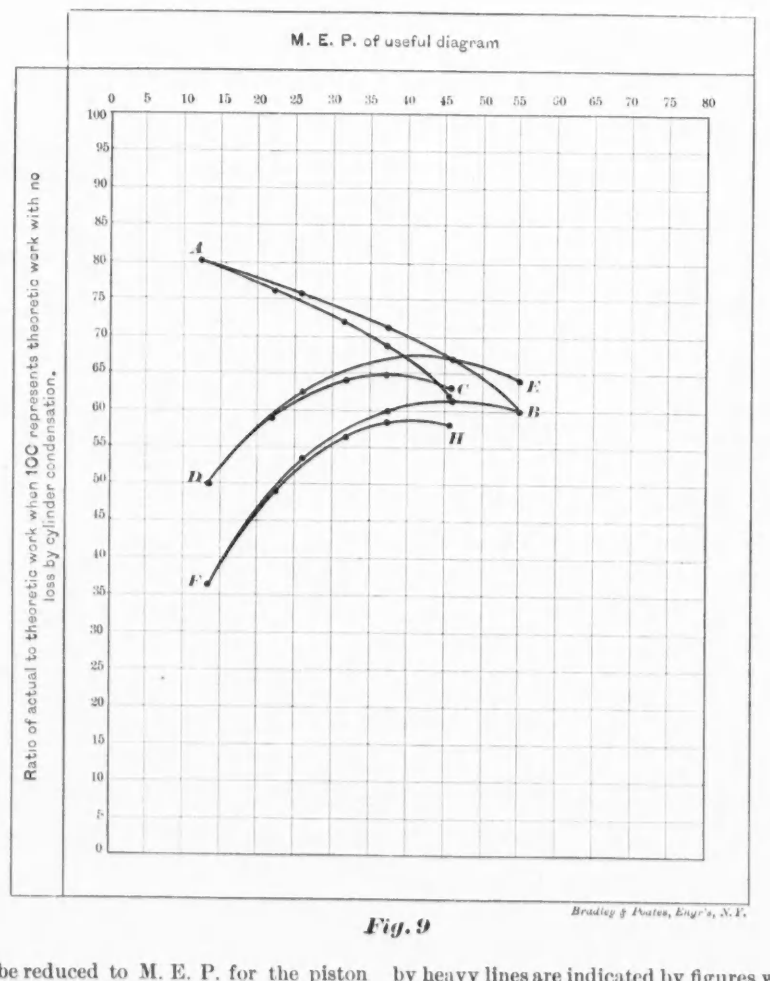

M. E. P. of useful diagram
Ratio of actual to theoretic work when 100 represents theoretic work with no loss by cylinder condensation.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
A
E
C
B
H
D
F
Bradley & Bates, Engr's, N.Y.

Fig. 9

Two such combinations are used in constructing the curves of Fig. 9, one where the compression curve of Fig. 4 remains constant through the series, and the other where the compression curve progresses through the whole series in harmony with the law that has been heretofore suggested. Fig. 9 represents the curves of efficiency produced by these two combinations under the following conditions:

(1) The curves *A B* and *A C* assume that the loss by cylinder condensation is directly in proportion to the M. E. P. of the diagram and is $\frac{1}{5}$ of the total steam in every case.

(2) *D E* and *D C* assume that the cylinder condensation is a constant quantity equal in amount to $\frac{1}{5}$ of the total steam used at $\frac{1}{4}$ cut-off.

(3) *F B* and *F H* assume the same cylinder condensation as in the latter case, and the curves show the net efficiency of the engine where the loss by friction is also a constant quantity equal to 8 per cent. of the capacity of the engine at $\frac{1}{4}$ cut off.

Each diagram of the series is used to establish one point on each of the curves of Fig. 9.

Thus *A* on Fig. 9 is established from Fig. 4 as follows:

M. E. P. = 13.4 and is measured on abscissa.

Cylinder condensation being assumed to be $\frac{1}{5}$ the total steam as stated, then the useful work in M. E. P. of diagram is only $\frac{4}{5}$ or 80 per cent. of the theoretic work, and is measured on ordinates.

The next point in curve *A B* is obtained from Fig. 5 as follows:

Total M. E. P. of diagram, Fig. 5 = 8.4 + 13.4 + 3.6 + .4 + 1 = 26.8 M. E. P.
Condensation is ¼ × 26.8 M. E. P. = 6.7 "
Total steam used, expressed in M. E. P. as follows:
Accounted for by the indicator, 26.8
Cylinder condensation, 6.7 } = 33.5
M. E. P. of useful diagram, 8.4 + 13.4 + 3.6 = 25.4
Efficiency, $\frac{25.4}{33.5}$ = 75.8 per cent.

The second point in curve *A B* is, therefore, 25.4 M. E. P. and 75.8 efficiency.

The points on curve *A C* are obtained in the same manner, but in every case the compression curve of Fig. 4 is used, and no measurements beyond that curve are included.

The curves from *D* and *F* are produced in a similar manner, except that the loss by condensation in the first, and condensation and friction in the last, are assumed to be a constant quantity, as already stated.

Whatever may be the truth as to the loss by cylinder condensation, it is evident that the best result under any circumstances is with the variable compression, as the upper curve of each pair is obtained in that way, while the lower curve is produced by constant compression. It will be found also that any compression curve which does not conform to the law under which these were made, will produce a curve of lower efficiency than the upper one of each pair in Fig. 9.

The condensation assumed by the curves from *A*, Fig. 9, is evidently far from the truth, as it shows the highest efficiency of the engine at the earliest point of cut-off.

These curves from *A* have been constructed to show that even with this extreme and impossible condition the varying compression shows even a greater gain than with the condensation which probably exists in practice.

The point *D* is probably a little too low, as cylinder condensation is not probably a constant quantity, and the true curve would, therefore, begin a little above *D*.

Following the curve *D E*, it will be seen that the highest efficiency is between 40 and 45 pounds M. E. P., while with the fixed compression of *D C* the best result is between 35 and 40 pounds M. E. P., and the difference at 40 pounds M. E. P. is about 3 per cent. of 65, or nearly 5 per cent. of the work done.

The curves from *F* show the wastefulness of light loads when the net work is measured as delivered to the belt, and it also shows the highest efficiency to be with nearly 5 pounds higher M. E. P. than when the indicated power only is considered.

* "Full compression" is here used to describe the curve which just reaches initial pressure within the vertical lines representing the piston travel, as *D A*, Fig. 1.

† The term "full expansion curve" is used to describe a continuous expansion curve, terminating on the line of back pressure within the limits of piston travel, as *B C*, Fig. 1.

The study of diagrams by this method of measuring the waste occasioned by free expansion suggests a possible application of the same method to diagrams from compound engines, both in regard to comparisons in each cylinder between the expansion and compression curves, and also comparisons between the various cylinders as to *all* free expansion losses.

This is, however, foreign to the subject of this paper, and will be left for another paper, which the writer hopes to present at the next meeting of this society.

On the Cultivation of the Inventive Capacity by the Solution of Constructive Problems.

BY LEICESTER ALLEN.

I regret that the pressure upon the columns of the AMERICAN MACHINIST unavoidably precludes continuity in the publication of the interesting letters and solutions called out in response to Problem No. 5, printed in the issue for April 13. I feel, however, that so far as *my* contribution to whatever interest the articles under the above title is concerned, the extremely interesting character of the contributions that have enriched the pages of this foremost exponent of applied mechanics, since the last of this series of articles appeared, has more than compensated for the enforced hiatus. I am glad to believe on the evidence of solutions very recently received, and from the tenor of nearly every one of the numerous letters which have been forwarded to me by the editor as they arrived, that the interest in these problems continues unabated notwithstanding the interval that elapsed between the announcement of the problem and the publication of the solutions which appeared in the issue of July 20.

The solutions selected for my last article were for the most part chosen as characteristic and typical of the large majority of those sent in. With the exception of the second solution of Mr. F. Van Fleet, shown in Fig. 3, the solutions therein given may be arranged in three classes. First, combinations of slide and connecting-rod, the slide being used to maintain parallelism of the connecting-rod with a line drawn through the centers of the driving and driven wheels. For brevity I will call this group of solutions "Class 1," and for the sake of a name will also style the movements comprised in this class "*Slide and Connecting rod Movements.*" Second, flexible shaft connections, which I will call "Class 2," and name "*Flexible Shaft Movements.*" Third, solutions which employ a third crank, which I will call "Class 3," and name "*Third Crank Movements.*" Fourth, solutions employing the pantagraph movement, of which the lazy-tongs is a variety, and which I will style "Class 4," "*Pantagraph Movements.*" There are a number of solutions that cannot be placed under either of these classes, and some of those which can be so classified possess such novel features as justify illustration and description.

Among solutions of the first class which have some special peculiarities is one contributed by Mr. Percy J. Neate, of Rochester, England, which not only fills all the requirements of the problem, but shows how another requirement might have been added. Curiously, the peculiarity which shows a distinctive feature in Mr. Neate's solution, not shown by any other yet sent in, arises from a misapprehension of what I intended to express in the enunciation of the problem with reference to the reversibility of the direction of rotation. He evidently understood that I intended reversing the direction of rotation of the driven wheel without reversing that of the driver, whereas I intended that both should be reversed when I wrote that this would be a desirable characteristic of the movement, though not an essential requirement.

I can neither improve nor condense Mr. Neate's description, and therefore give it entire, referring to Fig. 1, which illustrates his very ingenious device.

"Let *A* and *B* be the disks with their shafts in the horizontal plane *M N;* and let *a* and *b* be single crank-pins inserted at equal radii from the shaft. *C* is a guide plate, '*reed,*' like a lathe-saddle and carrying the vertical guide bars *D D* working in the guides *E E* attached to the elliptical frame *E'*, riding on the crank disk *A* and *B*, or on their respective shafts. Sliding horizontally in the guide plate *C* is the plate *F* with beveled edges and vertical slots near

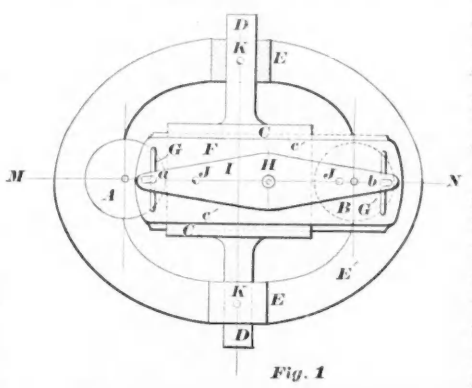


Fig. 1

its ends. These slots are the same distance, center to center, as the disks *A* and *B*. Exactly half way between the slots is the pin or stud *H* upon which the lever *I*, with slotted ends, pivots. The crank-pins *a* and *b* exactly fit the slots in *I* and *F*, and project through both. They may be fitted with square die blocks if necessary for heavy work. Additional pinholes *J J* pass through the lever *I* and plate *F;* and similar holes pass through the guide bars and guides *D* and *E*.

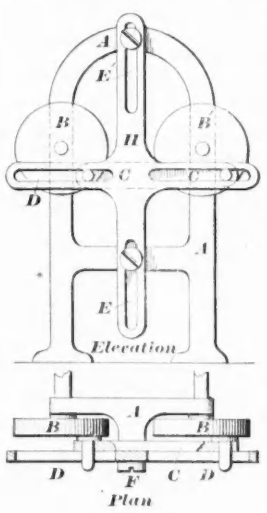


Fig. 2

"When pins are fitted in *J J*, the lever *I* is fixed horizontally; and when pins are in *K K*, the point *H* is constrained to move along the horizontal line *M N* only. One pair of pins only is provided. With pins in the holes *J J*, the slots are inoperative, and they then act as fixed round holes in the plate *F*, making it practically a simple connecting rod, constrained to keep horizontal, but free to move vertically or laterally under the direction of the crank-pin *a*.

"Obviously, therefore, if *A* is rotated, *a* will describe a circle; and so will any other point in the slide *F;* therefore *b* will also describe a circle. Moreover any given vertical motion of *a* will give an equal vertical

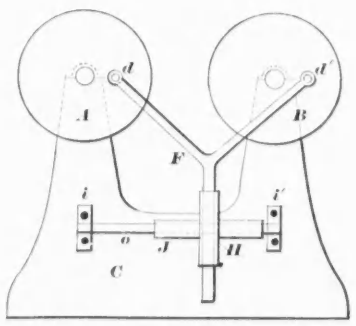


Fig. 3

motion in the same direction to *b;* and similarly with any given horizontal motion. Hence, the velocity ratio of the points *a* and *b* equals 1, and the motion will not be reversed.

"To reverse the motion, remove the pins *J J*, and place them in the holes *K K*, thus fixing *C* and *D D*, and freeing the lever *I* to vibrate on the fulcrum *H*. Now, if *A* be rotated so that the pin *a* descends, the lever *I*, pivoting on the central fulcrum *H*, causes the pin *b* to ascend exactly the same amount. At the same time, if the pin *a* moves horizontally, it engages in the slot *G*, moves the slide *F*, and the other slot *G'* drags the pin *b* through an exactly equal horizontal distance. Hence, the velocity ratio of the pins *a* and *b* still equals 1; but the direction of rotation is reversed as required by the problem."

Mr. Neate's solution shows that I might have made it a condition that both the driving and driven wheels should be made reversible, either both in the same direction, or each in a direction opposite to that in which the other might be moving at the time of reversing. The solution of the problem, if the motion of one wheel were permitted to be in opposite direction to that of the other, without any restriction, would, however, have been so easy as to render it puerile. All that would have then been necessary to solve the problem would have been an equal armed lever, pivoted midwise between the centers of the two wheels, and slotted at the extremities to receive sliding blocks fitted to the crank-pins. It was for this reason that one of the requirements of the problem stipulated that the two wheels should move both in the same direction and with an equal velocity ratio.

Two varieties of solutions in Class 1 were given in the issue for July 20, and Mr. Neate's forms a third variety. A fourth variety is shown in a solution contributed by Mr. W. Croker, Architect, of Orillia, Ont. This solution is illustrated in Fig. 2, and Mr. Croker's description follows:

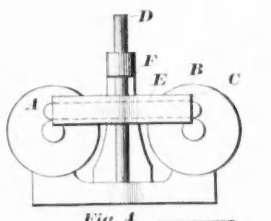


Fig. 4

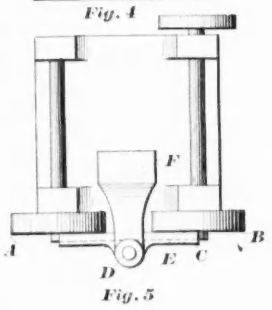


Fig. 5

"Referring to the sketch, *A* is the frame, *B* is the driver disk, having power applied to its shaft by any suitable means to give the required slow motion, and *B'* is the driven disk, both disks having shafts and bearings in the frame *A*. A connecting link *C* is applied loosely on the crank-pins, as shown, the crank-pins being extended and passing through the slots *D*, in the member *H*, said member *H* having slotted arms as at *E* and *E'*, and being confined to the frame by the screws shown. The crank-pins as they revolve about the centers of the disks are free to work in the slots of the horizontal arms of the member *H*, and act to produce a vertical reciprocating motion in *H;* the function of *H* being to carry the crank-pins over the centers where the link *C*, unaided, would fail so to do. The principle is presented in its most primitive form, in order to secure compactness, and is susceptible to several modifications."

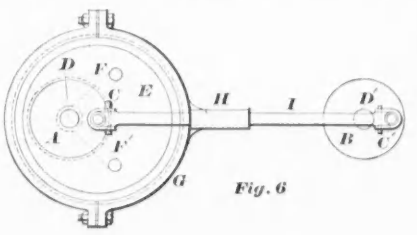


Fig. 6

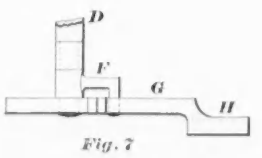


Fig. 7

The same principle is carried out in another way in the solution of Mr. John W. Broadhead, of Providence, R. I., whose solution is illustrated in Fig. 3. Mr. Broadhead expresses a superfluous doubt as to whether his solution conflicts with the second clause of the restrictions as given in the original enunciation of the problem which referred to the connection ordinarily used in coupling driving wheels of locomotives, which device his solution in nowise resembles.

The shafts carrying the disks *A B* are mounted upon the frame *C*. At equal distances from the centers of the disks the studs *d d'* are made fast, and they carry the Y-shaped connecting rod *F*. The lower prong of *F* is free to slide in the sleeve *H*, the latter being connected at right angles with the sleeve *J*, which slides freely on a guide-rod *O* that is held in fixed bearings *i i'* attached to the frame *C*.

Mr. Broadhead's arrangement affords a very simple and neat movement.

In Figs. 4 and 5 is illustrated another variation of this movement contributed by Mr. F. H. Treacy, of Brooklyn, N. Y. Fig. 4 is an elevation, and Fig. 5 is a plan view of Mr. Treacy's movement. Each disk is provided with a crank-pin, which works in a groove *E* formed in the flat bar *C*, the pins freely sliding in the groove, or, preferably, fitted with sliding blocks on the crank-pins. Secured at right angles with the flat bar and the groove *E* in the frame of the machine, and supported at the top by a bracket *F*, is a rod *D*, which serves as a guide; and this rod passing through a boss formed on the flat bar *E* maintains this bar in a horizontal line in all of its positions. Hence, when the dead centers are reached, the crank-pins are forced to pass these centers, and thereafter, until these points are again reached, the pins move with equal velocity ratio and in the same direction. The motion is reversible, as is the case with any of the devices of this class.

In Figs. 6 and 7 is shown a device belonging to this class which is the only one, so far submitted, that does not require an independent support or fulcrum unconnected with the disks themselves or their shafts. This solution has been contributed by Mr. James Tobin, of Brooklyn, N. Y. Fig. 6 is a side view and Fig. 7 a partial plan. *A* is the driving disk and *B* is the driven wheel. *C* and *C'* are the crank-pins, and *D* and *D'* are the shafts. *E* is an eccentric mounted on the disk *A* and connected by arms *F F'* to the shaft *D*, so that the eccentric turns with the shaft and with the disk *A*. *G* is an eccentric strap mounted on the eccentric *E*, and carrying the sleeve *H*. *I* is the connecting rod which is connected with the crank pin and fitted to slide in the sleeve *H*. The eccentric *E* having the same throw as the crank radius and moving with the crank and the shaft *D*, to which latter it is connected by the arms *F* and *F'*, causes every point of the eccentric strap *G* and the sleeve *H* to describe a circle of the same radius as that of the crank. At the same time, the connecting rod *I* acting through the sleeve *H* prevents the eccentric strap *G* from rotating on its own center, the sleeve *H* acting upon the connecting rod to carry the cranks past the dead centers, no matter in which direction the driving disk may be rotated.

Mr. E. J. Fermier, of Ann Arbor, Mich., has also contributed a solution which does not differ essentially from that of Mr. Croker, shown in Fig. 2. The same may be said of a solution contributed by Mr. J. P. Slocomb, of Providence, R. I., who has contributed some other solutions reserved for notice in a future article.

C. L. Redfield, M. E., of Chicago, Ill., and Mr. Walter Gribben, of Brooklyn, N. Y., have contributed solutions which consist of flexible shaft movements differing in no substantial particular from that of Mr. David Eddowes, presented in the issue of July 20. A similar solution has been sent in by Mr. Byron Getty, of Cedar Rapids, Iowa, who will please accept our apology for a misprint of his name in the discussion of the sliding-stock problem. Mr. Getty also sends in a solution which I cannot consistently accept, as it appears to violate the restriction that "belts of any kind, toothed gearing, friction wheels, or sprockets are excluded." His device involves what is substantially a toothed gear.

Open Jaw Die Sinking Press.

The accompanying illustration represents an open jaw die sinking press made by Watson & Stillman, 204–210 East Forty-third street, New York City. It is designed for striking off small medals and similar work without the annoying shock of the drop hammer; and, where power is not available, it will be found to be a very efficient tool. It is an adaptation of the improved hydraulic punch made by the above firm. The jaw is of ample strength to avoid spring. A lever in the lower shaft quickly brings the press ram down on to the work or raises it, while a few strokes of the upper lever does the work. The tool is provided with large wearing surfaces, and all its parts are easily accessible. Hard steel blocks are put in the ram and under it in the bottom of the jaw as bearing for the work. The body is of steel, and from its method of construction irregular dies may be used. The lower lever can, if desired, be made self-raising by weighting it at the rear.

These presses are made in three sizes; the smallest one weighs 130 pounds; the next 175 pounds, and the largest 240 pounds; they are capable of exerting a pressure of 60, 100 and 125 tons, respectively. Depth of jaw in all the presses is 2 inches; movement of ram, 1 inch.

LETTERS FROM PRACTICAL MEN.

The Chicago Exhibition—Water Supply—Water Glasses—The Great Eastern.

Editor American Machinist:

Whatever may be the shortcomings of the Chicago Exhibition in respect of lateness in completion and certain items of mismanagement which have set exhibitors and visitors on the growl, Americans may take comfort and know that this is a chronic failing in all exhibitions. The men who get onto committees have a tendency to manage things in the direction of themselves and friends. I remember a few years ago being at an exhibition in Edinburgh where the greatest fault was found with the refreshment caterer. Of course this as usual was a monopoly and was badly carried out. In the face of this part and the many warnings given them the managers of the succeeding exhibition at Manchester granted the same monopoly to the same people, and the result was that there was nothing decent to be got and that the price was high and the serving was dirty. This same exhibition held in the very center of the Lancashire engineering trades was so managed in certain other directions that not a single Lancashire boiler was employed in the motive power section. To let out any source of profit within an exhibition so as to grant a monopoly is to defraud the public of their just dues, to give a bad name to the show and keep away probably more visitors than would pay the revenue obtained from the monopolist. It is not that the committees do not know better but that in some way "vile self gets in," and their prayer is like holy Willie's, "Lord remember me and mine," the general public coming in for the damnatory clauses.

Then again as to the water supply of Chicago being drawn from a sewage polluted lake the real fault is not with the source of the water but with the destination of the sewage. I have just returned from the west of England where amongst others I was in the town of Taunton. This is a small place of less than twenty thousand inhabitants, but it is lighted throughout with electricity, and altogether is about as pleasing a town as one could see anywhere, and yet I believe it runs its sewage effluent direct into the river. Tiverton again a still smaller place and advanced enough to be contemplating electricity for its public lighting pours its sewage into the river Exe, and the City of Exeter pumps its water supply out of this same river lower down stream.

People who live in the great manufacturing districts of the north, and whose rivers are as black as ink from dye works refuse, have reason to be thankful for this as they are compelled to seek other sources of supply and usually go miles to some bleak mountainous district and save both the expense of pumping and the risk of disease.

Chicago is no worse than London except that London is supplied from a running stream which has only passed through such towns as Cirencester, Marlboro, Newburgh, Oxford, Wallingford, Reading, Henley, Windsor and a few others before London pumps it into the mains, and yet with a full knowledge of this men will take an oath and give evidence as to the suitability of the present supply for a city of five millions of people. There is no special reason for abusing Chicago that does not hold good with many other places.

Of course this does not make insanitary methods any less culpable in Chicago, but just at present there is so much being said against Chicago that one is tempted to think there must be something very wrong elsewhere from which attention has to be diverted. Mr. Miller condemns the eating facilities at the Fair, but so it is in all of

Hydraulic Embossing Die Press.

them, and the caterers have all the idea that coat sleeves may be used at table in place of linen. However, plain deal boards are preferable to the dirty coverings we had at Manchester.

The silliness which distinguishes exhibition managers was by no means absent in Paris in 1889. An American engineer who was making a pocket-book sketch was to my knowledge stopped from doing so, and I heard of a pocket book being actually sequestrated by the French officials.

Engineers owe a debt of gratitude to the recent meeting of the Master Mechanic's Association for pointing out that the water gauge glasses on a boiler are not necessary. We want a few more such resolutions as this to rid us of some of our superstitions. There are in this house about a score of glazed windows and doors through which it is possible to see direct to the roadway or the garden. I propose now to have all these bricked up, leaving here and there a loose brick which can be removed if occasion arise to look out. By so doing we shall avoid the expense of a law suit which we might be tempted to commence against anyone who broke our glass. I had long intended to abolish windows as an unnecessary luxury, but had thought the constant removal of loose bricks might draw attention from our other occupations. Now, however, I feel sure that as there is so little use for glass water gauges there can be none for windows. I really wonder that glass is allowed to be made for any purpose whatever.

Is there not an error in Mr. Durfee's account of the launching of the "Great Eastern"? I have always understood that hydraulic jacks were not employed until after the ship had moved and stuck on the ways, and that in fact the hydraulic jack was practically called into life by the demand for some moving apparatus, the bonus of $50,000 given for this apparatus—Tanzye's hydraulic jack—being the means of giving the firm of Tanzye Bros. that start in business which has continued to the present day. I do not vouch for this, though I was told of it by a man who should have known.

W. H. Booth.

Black Prints vs. Blue Prints.

Editor American Machinist:

Your correspondent, Mr. C. Willich, in an article on the progress of photo-printing, July 20, 1893, says: "It would undoubtedly be a great improvement and of much advantage if positive black prints could be made as easily and as cheaply and with as much certainty as blue prints." Now I wish Mr. Willich or some one would tell me just what the advantage or improvement would be, as I have been using blue prints for the past twelve or fifteen years, and think they are good enough for any one to work from. I really do not think there is much of a demand among mechanics for black prints, as they will get black soon enough after they have been out in the shop a few days. Would like to hear from other readers of the American Machinist in regard to this matter.

Speaking of blue prints, in our practice we get better results by keeping the two mixtures, that is, the citrate of iron and ammonia, and water, and the red prussiate of potash and water in two separate bottles, and mix them together in equal parts as needed. We have made prints with this preparation after it had been put up for five years, with good results. C. R. Carley.

Simple Micrometer Adjustments.

Editor American Machinist:

A great many machinists are not aware of the utility of a knowledge of the pitches of the principal feed-screws in a machine tool which they may be running. It is certainly a fact that a great amount of time is spent on any job requiring even a slight degree of accuracy—in calipering, trying, or otherwise measuring it. A cut is started, stopped, and the work tried by some method or other, depending on the machine and the job, and always consuming more or less time. The cut runs out, and another is started, stopped and tried. Perhaps it must be lightened or deepened, and then the new cut must be tried, and so on for each cut. Of course, it is not always necessary to measure for each cut if the machinist is experienced and possesses the intuitive ability to do the right thing, and know when he has done it without any investigation. But at the very best an amount of time, not by any means to be sneezed at, is spent in this manner.

But every machine hand is provided with a most easily applied and simple method of gauging his cuts, if he knows that a certain revolution of a feed-screw handle means an eighth, a sixteenth, or whatever it may be, in the depth of his cut. Of course, some feed-screws have rates not as convenient as others for use in this manner, but nearly all can be used to some degree.

Where the pitch of a feed-screw is a power of two, as four, eight, sixteen, or thirty-two, two turns, a turn, half a turn, a quarter-turn, half a quarter-turn, etc., means, of course, so many sixty-fourths, and a knowledge of just how many will save considerable time in measuring.

There seems to be a growing disposition among manufacturers of machine tools to have feed-screws with rates that are a power of two, and the advantages of some uniform rule of practice in this connection furnish a subject for future discussion.

It will often be found most convenient to index the principal feed-screw used in setting cuts, as the transverse feed in a lathe or boring mill, or the vertical feed in a shaper or planer crosshead. This may be done more or less elaborately, even to the extent of providing a regular hand and dial, as is nearly always done on modern milling machines. The following plan, however, will be found sufficiently exact for ordinary purposes.

The handle is to be removed, and if the part immediately next the bearing surface is not circular, a little filing, or better yet, a few moments in a lathe, will provide a space which can be graduated with a small pair of dividers, into halves, quarters, sixteenths, etc. The lines can be cut with a light chisel, or heavily scratched. It is best to make them in the same manner as on a scale, as regards length, and to stamp with small figures the parts of the circumference which correspond to some convenient part of an inch. For instance, if the screw has eight threads, one turn of the handle is an eighth of an inch, and a half of a quarter turn a sixty-fourth. These eight divisions can be marked 1, 2, 3, 4, etc., meaning so many sixty-fourths of an inch in the lateral motion of the tool. If the screw has four threads, the eighths of the circumference will be, of course, thirty seconds of an inch, etc. If the pitch be six, or twelve, and the circumference be divided into eight parts, three divisions will be a sixteenth or a thirty second respectively.

A stationary mark is next to be made opposite the index, and in the most convenient place for observation. Sometimes an idle washer is between the handle and the stationary bearing surface. If this is too long to conveniently use a mark on the latter, the washer must be marked, and of course made stationary. A few heavy center punch marks on the line of separation when the washer is in place will usually suffice, or a small groove may be chipped in both surfaces and a pin inserted.

If the pitch of the screw is a multiple of five or seven, it is hardly worth while to index the handle. If there are fourteen or fifteen threads, slightly less than a quarter turn will give a sixty-fourth. For five or ten threads, a little more than a quarter turn is a sixteenth or a thirty-second respectively, and for seven threads a little less gives a thirty-second.

It must be remembered that if the machine tool has a reciprocating motion, as in a planer, moving the tool any distance will have the *same* effect in reducing the size of the work, but if the machine has a rotary motion, as a lathe, any movement of the screw has *twice* the effect as regards the size. Thus if a cut of an eighth of an inch is taken in a planer on a job an inch thick, the finished size will be seven-eighths, but if an eighth is taken off a job in a lathe an inch in diameter, the work is reduced to three quarters.

The applications of the ability to take a cut of any desired depth without measuring are numerous. When work is to be brought to a certain size, taken from a scale, the operation is very easy.

The present size of the work being ascertained, and the given size subtracted from it, the tool is brought up to touch the work, moved off, and fed in the necessary amount, less whatever may be required for a finishing cut. When the cut runs out, the exact amount to be removed by the finishing tool can accurately be obtained from the finished surface, and the finishing tool fed in the distance required. One who has never tried this plan will be surprised at its ease and accuracy. In nearly every case the correct size will be obtained at once, and all of the time of setting a new cut, calipering it, etc., will be saved, besides avoiding the difficulty of making a true surface when a cut is deepened and started over again before it has run out.

If the stock to be removed is more than the machine can take at one cut, the fact is easily found out, and two cuts of half the required amount can be taken without injuring the edge of the tool, whereas if the first cut had been taken up to the capacity of the machine the edge of the tool would certainly not be in as good a condition to make the second cut as if the first method had been adopted.

If a number of cuts are to be taken, it is readily known when the work is near the desired size without calipering each cut.

It will always be found best in any case,

however, to measure the work after the first cut is started and gauge the cuts from that, instead of from the size obtained from the rough surfaces, as the latter is hardly to be depended upon.

If a certain depth is to be cut in in any manner, as a keyway in a planer, shaper or slotter, or a counterbore in a lathe, the right depth can be secured without any measurement at all, beside knowing just the point when the depth will be secured, and so taking heavy cuts until this point is nearly reached, and then easing off on the feed to give a better finish to the bottom, and at the same time avoiding the waste of an instant.

If work is to be brought to agree with a size obtained from other work by calipering, etc., of course the exact size can hardly be expected to be obtained by measurement, but by working in the manner indicated it is readily known when the size is nearly correct, and the work is done with greater facility, as a trial will readily prove.

In fact, in any case whatever, given a certain size and a certain depth of cut, the resulting size can be known, without measurement, to a degree of accuracy surprising to one not accustomed to follow this method of working. Even without an index a quarter turn and half a quarter turn can be readily made, and with very little practice a close approximation to a sixteenth of a turn; and as the difference between threads in any short distance in a screw that is even very badly worn is hardly appreciable, sizes obtained in this manner are far more accurate than can be obtained from a scale.

The above remarks apply more particularly to transverse feeds in machine tools, but the principle can be applied to lateral feeds to some extent. In a lathe the rate of lateral motion can be most easily obtained by actual measurement, and even then the amount of revolution for a given distance is so small in proportion as to render it hardly reliable. But in a planer or any other case where the amount of revolution does not correspond to too short a distance, there need be no necessity for measurement until the correct size is known to be nearly attained.

A little use of the methods indicated will readily suggest to an intelligent workman such modifications or extensions as may best be applied to the work in hand, and it will not take very long for a machinist to satisfy himself that it is not often necessary to use a scale or calipers, except to find an initial size and verify the final cut.

San Francisco, Cal. S. A. Moss.

Siphons.

Editor American Machinist:

In answer to Mr. Torrey on siphons in your issue of June 15 the following may be of interest: Having charge of machinery at a large coal mine, I had to put in a 3″ siphon 1,200 feet long. The pipes were ordinary 3″ cast-iron pipes.

We had some trouble first, but when we got all the air out of pipes it run right along for two months, when we got more water and had to put one more 3″ pipe in. Got it started and the two siphons run for two years. The only trouble we had with them was to shut them off occasionally when the water got low, as the two siphons were larger than the incoming water would supply, though we expected to get more water.

At another place we put in a 6″ siphon 1,800 feet long, but having so many bends in it it did not give complete satisfaction, but it kept the water out (with some trouble) until we got our hauling engine ropes to the place, when we put an 8″x20″ double-acting pump in and used the pipes for delivery, but had to put 1,200 feet more pipe on to deliver the water to shaft.

Could give you more cases but think I have written plenty at this time.

Geo. Coates.

There is everything in a name. The newest sight feed lubricator of which we have heard is called the "isothermal," and saves, of course, from "five to twenty per cent. in fuel."

Rules and their Exceptions—It Pays to Think.

By Peter H. Bullock.

Very few rules are like the laws of the Medes and Persians, which could not be changed and were not to be broken. On the contrary, most rules of the present time are proved by their exceptions and frequently most honored in their breech. Some other rules are made for the protection of owners and managers, and are not only openly disregarded, but they must be in order to perform regular and routine work. I have often been taken to the upper floors of buildings on elevators that carried signs warning all persons not to ride, as they were for freight only.

A friend runs one of the fast trains on the Blank & Blank R. R., the rules of which provide a maximum speed that must not be exceeded at any time, also a certain speed for the yard limits of five places, and that the train must be got under control at two junctions and two bridges, beside which a full stop is made on the division referred to. My friend breaks all these rules every day—if he didn't he could not make time; if he didn't make time he would be asked for reasons why; if he should give the above quoted rules as reasons he would find some other fellow on the footboard. If an accident should occur that could be attributed to the disobedience of any of these rules, they would protect the management and convict the personal offender, notwithstanding the fact that the time can not be made without exceeding the speed given in the rules for both road and yard limits.

About a year ago I listened to a practical talk by a special agent of the railway postal service, and in describing the intricacies of the business and the confusion of routes, he read a rule of thirty words, telling how to send mail for certain counties in New Jersey and Pennsylvania, the rule ending with "see appendix of exceptions." On looking up this little supplement, it was found to contain 390 exceptions wherein the original rule did not apply, and these exceptions by no means remained constant, as they were often changed by new routes and offices being added.

For one I am not as dogmatic as formerly; I do not make as many rules for the guidance of subordinates, but try to indicate the way things are to be done by words of commendation or reproach as the case may deserve, and by trying to cultivate the habit of thought regarding the work and the best way of doing it. I do not know as the reason that a man was thinking would be received very many times as an excuse for idleness, yet the most valuable services my employers ever receive from me is when I think, and just so if a subordinate will think intelligently about his work those thoughts will be a good investment, even if they are at the expense of a little time lost to manual exertion.

No, the superintendent and foreman are not the only ones who can think to advantage; every mechanic, fireman and laborer can also use his thoughts so as to lighten his exertion and increase his efficiency. If a man is only sure he is right, he can, then, like "Davy Crockett," go ahead, but if not sure it will pay to spend some time in finding out. Conditions will vary slightly in work of the same general character, and it would be found that any rule of procedure would require an ever-increasing list of exceptions. Not long since a Chapman valve was to be unseated, and I instructed the workman to hold the wheel still while the top part was being unscrewed from the body, for in this make the screw is on the end of the stem and on the inside of the gate piece, so that by holding the stem the turning of the top out of the body does not affect the gate except to slowly withdraw it. This was all right for a Chapman, but in a few days a Peet valve was to be unseated, and the man followed my former instructions by holding the wheel while unscrewing the top part out of the body. Now in the Peet the screw is on the middle of the stem and in the top part, and of course as the latter was turned to the left it was slowly being raised from the body, as the threads were sixteen to the inch, but the stem with threads six to the inch being held, made a differential screw of the thing and the valve was sprung and spoiled. In this case it was my fault not to have explained that this way was right only when the valve stems were *not* threaded into the top part, and it was the workman's fault that he did not take notice of the difference in construction of the valves—that he did not think. Good, every day mechanical thought would have been worth a dollar a minute if his "think" mill had been in running order.

I once had a fireman running a group of tubular boilers set in brick-work, and he was instructed never to blow them off until four hours after the fires were out of the furnaces. The man got another situation on my recommendation, and in a few weeks I got a letter from his employer asking me if it was a fact that I had taught the man never to blow off a boiler, etc., etc., and if so, if there was any good reason for it in his case where fire box boilers were used. Of course, I could only answer that there was not any good reason in his case, that the former rule was good safe practice for brick-set boilers, but entirely unnecessary in the case of those internally fired. I could then see that I had done the man an injustice in instructing him in a rule of procedure without pointing out to him that it had an infinite number of exceptions, and, in fact, was only good where the conditions were as they existed in the original case. On the other hand, my protege should have seen the different conditions, and reasoned that in one case the brickwork would hold heat enough to seriously injure an empty boiler, while in the other the heat is all *in* the boiler, and that it is as safe to blow in one minute after the fire is out as it is in an hour or a day.

Notes from a Fire Room.

By Wm. J. Williams.

The facts herein related were the results of experimenting with different brands of coal, whether the coal evaporated as much water per pound of coal or whether the steam was as dry as should be was not under discussion From experience and observation it is believed that the steam plant from which these notes were made is equal to any other and vastly superior in its appointments to keep things as they ought to be for economy of fuel to many others of more pretentious plants.

The boiler was a plain tubular 10 feet long with fourteen four-inch tubes; diameter of shell, 36″; dome, 24″ by 24″; grate surface, 10½ square feet; total amount of water heating surface, 215 square feet; height of chimney above the grate, 58 feet; area of chimney where top boiler flue enters it, 169 square inches; area of top of chimney, 324 square inches.

Kind of engine, a plain slide valve; diameter of cylinder, 10″; length of stroke, 16″; revolutions per minute, 148; point of cut-off as per valve, 59 per cent. and 60 per cent. of piston stroke; boiler pressure, 80 pounds per square inch; the boiler in addition to running the engine had to furnish small quantities of live steam and had been pronounced again and again as too small for the work required of it. This conclusion seemed to have several grains of truth about it so long as a low-priced fuel was used.

There seems to be a popular impression with many who pay the coal bills that the less per ton of coal paid is the best kind of economy; to a certain extent this may be true if one have a large boiler with small demand on it; then, as the expression has often been made, "I can burn anything." In many places the total cost of coal per ton is decided by the amount of money required to cart away the ashes from a ton of coal, and as in some locations the price paid per coal cart-load amounts to as much as one dollar and a quarter, and is an item worth watching, it is a question whether the quality of fuel best suited to any location should not be decided by the ability or ease with which the steam pressure can be kept the most constant; any loss of pressure causes a diminution of speed of the engine and a consequent lessening of work performed in a given time.

Among the things noted was the capacity in cubic feet of a one ton coal wagon, which was found to be 32.18 cubic feet. The first lot of coal to experiment with was 8,960 pounds (4 gross tons) of Lykens Valley pea coal at a cost of $3 65 per ton. It run the plant 66 hours, and the above quantity of coal made 28.35 cubic feet of ashes, showing that it would require the burning of 4½ tons of this brand of Lykens Valley coal to fill a one ton coal wagon. There was no trouble in keeping up the pressure in the boiler; all symptoms of crowding disappeared.

The second sample of coal experimented with was 4 tons (8,960 pounds) of white ash anthracite pea coal at $3 25 per ton. This lasted 60 working hours, and it made 39.06 cubic feet of ashes. To fill a one-ton coal wagon it would require the burning of 3.30 tons of this brand of coal; its steam making quality was good but not equal to the Lykens Valley above noted.

The third sample was 2,240 pounds of what was termed No. 20 anthracite coal at a cost of $3 per ton; this quantity run the engine 15 hours, and it left of residue 16.20 cubic feet of ashes. The burning of two tons of this brand would yield ashes enough to fill a one ton wagon. During the burning of this ton of coal it was impossible to keep the steam pressure up to the working limit at all times; the firing required the most constant attention with anything but satisfying results. It would seem from the result got from this ton of coal, so far as the time it lasted, that it was on a par with the $3.25 per ton coal. The former failed in its work to keep up the pressure, principally on account of the heavy deposit of ashes on the grate preventing a sufficient supply of air to properly burn the fuel.

The fourth sample experimented with was 8,960 pounds of Lykens Valley pea at $3.50 per ton of 2,240 pounds; this was bought of a different party from the first lot of Lykens Valley coal. It lasted 63 working hours and produced 31.50 cubic feet of ashes or the fraction of a cubic foot less than the volume of a one ton coal wagon; the result in work was satisfactory, and it was adopted as the fuel of the future. Below is a tabulated statement of results:

Kind of Coal.	Cost per ton (2,240 lbs.)	Quantity in pounds.	Ashes in cubic ft.	No. of hours work done.	No. of tons of coal burned in one load of ashes.
Sample No. 1 Lykens Valley pea coal.....	$3 65	8,960	28.35	66	4.50
White ash anthracite pea coal.....	3.25	8,960	39 06	60	3.30
Anthracite No. 20	3 00	2,240	16 20	15	2 00
Sample No. 2 Lykens Valley pea	3 50	8,960	31.50	63	4 08

It is unusual to express the amount of non-combustible matter of a fuel in bulk instead of by weight, but in this case it was not convenient to weigh the ashes nor would it convey any more information than was desired than was obtained by the mode adopted. There was a certain number of square feet of grate surface to burn the fuel on and the fire could not be cleaned while the engine was working. To attempt to do so would be a virtual shutting down. The fuel needed was that that would leave the least amount of residue on the grate to obstruct the passage of air through the fuel, so that the work could be carried on until a convenient time to clean the fire, which was at noon hour and after 6 P. M. only.

It is generally voted that the Engineering Congress held at Chicago was pre-eminently successful and very beneficial to all who were able to attend it.

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J. G. A. MEYER, } Associates.
FRED J. MILLER, }

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Headquarters at the Fair.

During the continuance of the Chicago Exposition the AMERICAN MACHINIST will have its headquarters in the space allotted to the Mechanical Press in Machinery Hall. The exact location is Section No. 27, Column K 37. Word can be left with the attendant there by any one who is desirous of meeting a representative of this paper, who may at the time be engaged elsewhere on the grounds. As the majority of our friends who visit Chicago during the continuance of the Fair will spend a considerable portion of their time in Machinery Hall, we invite them to make use of our facilities there by having their mail addressed in our care as above, where it will be cared for and delivered on demand either by our own representative or by the person who cares for the space in which our desk is located.

Wasted Energy.

The amount of energy wasted on "invention" by those with a smattering of mechanical knowledge is strikingly large. A doctor or a lawyer goes through some sort of a course of training before he practices his profession, but notwithstanding all his practice teaches him how little he really knows about what he has studied all his lifetime; when it comes to mechanical matters he is quite likely to consider himself competent to astonish the world—which he not unlikely does in a limited way and in a direction contrary to what he had expected. There appears to be a special fascination about things mechanical—about levers, and wheels and springs, and the like, that gets a stronger hold on men who know nothing to speak of about them than almost anything else. Men seldom think themselves great lawyers or doctors until after they have spent some little time in study or practice, but the same men think they can invent such trifles as steam engines and complicated machinery without preparation.

The daily papers find an excellent field in exploiting the inventions of these men who are to revolutionize things generally, and the matter when written up by the average reporter—smart though he may be, when he "sticks to his last," is amusing anyway, and so does not quite waste the effort.

The patent office aids and abets this waste of energy by issuing patents that are to bring about results by means that set aside most physical laws, and so it goes on.

There is no way of preventing the waste of this energy that is spent to no purpose. It is almost dangerous to tell a man who knows nothing about the subject that he has invented nothing, or conceived only impossibilities. The one who does it may not sustain bodily injury through reason of his frankness, but he may be reasonably certain that for about every time he does so at least one man has writen him down fool, and that isn't pleasant.

In hundreds of instances men refrain from saying what they think—or know—in such matters, because in the first place they do not believe it would do any good, and in the second place, because they shrink from even being thought ignorant.

If all men would confine their inventive soarings to directions with which they had some acquaintance, there would result a saving of a vast amount of human energy, or energy now wasted would be expended in profitable directions. But perhaps it is too much to expect that they will ever do so.

Boiler Explosions.

It is indisputable that the number of boiler explosions in this country is alarmingly great, and it is equally true that a boiler does not explode without there being a very good reason for it—a very good reason and a very simple one. There was a time when it was believed by many that there were hidden causes for many boiler explosions, and a rather flourishing, if not renumerative, business was done in the theoretical manufacture of some mysterious gas that never could be made to materialize except just at the time when no one had time to detect its presence, and the boiler went to pieces. There are, perhaps, still a few left who believe in the gas theory of boiler explosions, but their number is very small indeed, so small as to make no impression on current opinion. An overwhelming majority of engineers at the present day believe that if the cause of a boiler explosion is looked after in the right way, it will be found without the necessity of making some old gas theory do service, or inventing a new one; without bringing into the argument any unaccountable or unheard-of action of the water, or in any way going outside of what plain people can understand.

It would seem that, with rather clear sailing in the matter, with the knowledge that a boiler lets go just as, and for the same cause that, steel or iron in any construction fails, boiler explosions would be something of the past, but after all bridges fail and chains break, because well-known laws are not complied with, or approved practice followed, and so, too, boilers explode.

Safety in the use of a boiler is assured by proper construction in the first place, and correct practice in attention to and maintenance of it afterward.

This is easy to say and ought to be easy enough of accomplishment, but the every-day record of boiler explosions shows a great amount of ignorance and carelessness in these matters—either this or something worse.

Rigidly enforced inspection and license laws ought to provide the needed remedy, but it seems about impossible to secure such laws except in rare instances. Engineers, who ought to know their value, have worked for them for years, but with very indifferent success. Money and politics are against them, and money and politics generally win. The objections of boiler owners to laws that would bring about inspection of boilers and licensing of engineers are money objections, and politics is the means of preventing the passage of such laws. The history of the attempts of engineers to bring about the enactment of laws to the ends named would be interesting if published. Promises to the desired end are the easiest thing in the world to obtain from legislators, but there is no intention of keeping such promises, and the really interesting, and what would be instructive thing if published, would be the ingenious manner in which these promises are broken while the semblance of keeping them is maintained. There is little hope for protection against boiler explosions through general laws for inspection and license.

There is one other plan against which boiler users could not very well object. Admitting that inspection will cost them something, and that a properly qualified engineer cannot be hired to work for as little money as a man who knows nothing in particular about the business, still these grounds for objection would be untenable except that they do not believe their boilers will explode; in fact, we are rather bound to believe that they would not endanger life for the saving of a few dollars. Then let there be a law that shall provide for determining the exact cause of every boiler explosion and provision for publishing this cause. If Mr. Smith's boiler disastrously fails, because he has neglected to have it kept in proper repair, or because he put it in charge of Incompetency, or because he failed to have it examined in a way to determine its condition, let Mr. Smith's full name and location, together with all the facts in the case, be published by authority. He could not object to the passage of such a law, one of the provisions of which should be that nothing should be disturbed about the surroundings of the explosion until after full legal investigation, because his boiler is one of those that is not to explode. In other words, those who objected to such a law would—if the rather common expression may be used—give themselves away.

We are of the opinion that the enforcement of such a law without the attachment of any penalty except one against failing to report an accident to a boiler, or placing obstacles in the way of investigation, would result in a rather remarkable decrease in the number of boiler explosions. There are quite frequently—most generally—circumstances connected with such disasters that would not look well in print, authoritatively circulated. A remedy is wanted. We submit this.

Crowded Public Conveyances.

Americans have a world-wide reputation for being a long-suffering people, and in no way is their willingness to enjoy inconvenience better illustrated than in the overcrowding of public conveyances. This is something that strikes Europeans when visiting this country for the first time forcibly, and upon which they comment in a way not complimentary to American practice in this respect. Accustomed to traveling where the law entitling them to a seat is vigorously enforced, they cannot readily comprehend the anxiety of Americans to stand up, cling to straps, crowd one another, etc., in their rather mad rush to get somewhere.

The difference in this respect is largely due to difference in temperament; to the American idea of crowding as much of everything as is possible into the briefest time limit. When Americans come to really want some of the comforts of travel in cities and on ferryboats that are enjoyed in Europe they will get them without trouble, get them through the operation of the law just as they do there. But no one here would find as much fault with a law governing this matter as those who make use of public conveyances. Any law that delayed people two minutes in its operation to the end of securing them seats in street cars, for example, would be resented as an undue interference with their inborn right to stand up.

Companies that transport passengers in and about American cities profit through this peculiar trait of the people, and will continue to do so until Americans conclude to wait long enough to compel them to do differently, and more decently, in respect to overcrowding.

It is generally assumed that the companies that provide public conveyance are the ones in fault for the crowded condition of cars and boats. This is only partly true. Of course, in most cases, they could supply increased facilities, but after all, why should they be expected to do so when they can make more money with fewer? It would not be in human nature that they should, and it is rather certain that they will not unless constrained to do so by law or urged by competition. It is the people that are in the main to blame, if they can be blamed for getting what they appear to want. To be sure "Pro Bono Publico" and "Constant Reader" air themselves, sometimes, in the daily press in relation to the matter, but no one, and least of all the car and ferry companies, believe they are very much in earnest.

Literary Notes.

MANUAL OF THE RAILROADS OF THE UNITED STATES FOR 1893, showing their route and mileage; stocks, bonds, debts, cost, traffic, earnings, expenses and dividends; their organizations, directors, officers, etc. By Henry V. Poor.

This manual contains, as its predecessors, interesting and reliable statistics relating to railroad matters, and will be of valuable service to those interested in railroad investments, bonds, dividends, etc.; or any one seeking information regarding the operation and rolling stock of railroads. It may be interesting to note that length of track laid up to December 31, 1892, is stated to be 175,223.44 miles; net increase of mileage of all railroads in the United States in the calendar year 1892, 4,428.91 miles. During the fiscal year 1892, there were 170,606.84 miles of railroad operated exclusive of elevated railroads. Passengers carried, 575,769,678; passengers, mileage, 13,697,343,804; tons of freight moved, 749,331,860; tons of freight moved one mile, 84,448,197,130.

The manual is published by H. V. & H. W. Poor, 70 Wall street, New York.

The second volume of the *Compass*, a monthly journal for engineers, surveyors, architects, draftsmen and students, has recently been issued. Like its predecessor, it contains much that is valuable, useful and interesting to the engineering profession. It treats principally on the construction and use of mathematical instruments, but it also has many items of a technical character, which will undoubtedly be appreciated by the reader. The volume reflects great credit on its editor, William Cox, and its publishers, Keuffel & Esser Co., 127 Fulton street, New York. The first and second volume of the *Compass* can be had, bound in cloth, for $1.75 each, postage prepaid.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(417) R. A. G., Bethlehem, Pa., writes: Please inform me if there is any rule for finding the weight of brass and iron castings by weighing the patterns which are made of white pine. *A.*—Multiply the weight of the pattern in pounds by 19, the product will be the weight in pounds of the brass casting. For cast-iron multiply the weight of the pattern by 16.7.

(418) S. L. O., Newark, Ohio, writes: I wish to know if there is a chance of improving a patented article; can this improvement be patented without getting into trouble? *A.*—The improvement can be patented provided you do not infringe on the original patent. In questions of infringement, points may arise which require experts to decide upon. A good patent solicitor should be capable of giving you good advice in the matter.

(419) E J. B., Philadelphia, Pa., writes: Inclosed please find sketch of a hollow semi-circular casting; it is to be made of cast-iron. Can the core be held in place with one core print only, so that the opposite end can be cast solid? Or will I need a core print at each end? *A.*—You can get along with one core print only; in fact you may discard both core prints, but in either case you will have to use chaplets. See our issue of October 20, 1892.

(420) B. M. M., Syracuse, N. Y., writes: Kindly inform me of some process of drilling glass. *A.*—Put a piece of brass tubing in the drill press spindle, the outside of the tube being equal to the size of the hole you desire to make; revolve rapidly and feed with emery and water. For thin glass the following method may answer your purpose: Stick a piece of stiff clay or putty on the part where you wish to make the hole. Make a hole in the putty equal in diameter to that of the desired hole in the glass, reaching the glass of course. Into this hole pour a little molten lead and the piece will immediately drop out.

(421) F. W. S., West Haven, Conn., writes: Please refer me to any good work treating on the source and manufacture of oils. I am inclined to think that there is a scarcity of literature on this subject. *A.*—The literature on this subject is scarce. Practical treatise on animal and vegetable fats and oils, comprising both fixed and volatile oils, their physical and chemical properties and uses, the manner of extracting and refining them, and practical rules for testing them, by W. T. Brannt, may suit your purpose. 2. Am I right in using an oleometer marked "U. S. Petroleum Asso. for Coal Oil"? *A.*—We see no reason why this should not answer your purpose.

(422) F. C. K., Muncie, Ind., writes: Please inform me if there is any thing I could put under legs of an Acme engine to deaden the noise while it is running. It is a 2 horse power engine, and runs at a rate of 450 revolutions per minute. The engine is placed on the second floor, and the parties underneath complain of its noise. Every thing is in good working order, but it makes a humming noise. *A.*—We should bolt the engine to a cast iron plate extending over a considerable area of the floor, and place asbestos felting about one inch thick between the plate and the floor, and bolt them firmly together. It is possible that an adjustment of valve gear may also reduce the noise and vibration, which, to a greater or lesser extent, accompanies the running of an engine.

(423) J. G. F., Providence, R. I., writes: Please inform me if there has ever been a machine invented for setting type. *A.*—Yes; there are now quite a number of them in successful operation. 2. If there are such machines, how many ems per hour can be set with the machine; also how many ems can a good man set up per hour? *A.*—The number of ems that can be set up depends on the size of type, as about $\frac{1}{3}$ of the time is occupied in spacing out the line. Large type requires a greater number of lines, and consequently more time will be required for spacing out the lines than when smaller type is used. It is considered that from 1,000 to 1,200 ems per hour set up by hand is a good average, and with type setting machines at least twice that amount of work is expected.

(424) G. A., Leadville, Colo., writes: We have a 15 horse power portable boiler, in which the stays running from the crown sheet to the furnace door sheet are broken; the ends of these stays are riveted to the sheets above mentioned. There is a small hand hole in the head only. Please inform us of the best way of putting in new braces. The boiler is in the country. *A.*—It seems to us that you should be able to contrive some way of passing the rivets through the top of dome and holding them until they are riveted from the outside. But if this cannot be done, you will have to bolt the stays to the sheet. The bolts can be passed into the boiler through the hand hole, and then drawn into the rivet holes by means of a wire. Of course, this method may be somewhat troublesome, but it is often adopted were braces cannot be riveted to the sheets.

(425) W. K., New York, asks: Is there not a mistake in Mr. Barnhurst's rule as given in his article on page 6 in your issue of February 9, current volume? Namely, 1 horse-power requires 550 square feet of belt contact. Some rules give 1,000 feet per minute per inch wide for a horse-power. This would equal to $\frac{1,000}{12} = 83\frac{1}{3}$ square feet instead of 550. *A.*—There is evidently a mistake in Mr. Barnhurst's rule; it escaped our notice, or we should have had it corrected. We thank you for drawing our attention to it. Even an allowance of $83\frac{1}{3}$ square feet per minute is, in our opinion, too great; our custom is to allow 60 square feet per minute, or 1 square foot per second per horse-power, a rule which is easily remembered, and which generally gives good satisfaction.

(426) W. H. M., Independence, Mo., writes: I am a machinist, and have had five years' experience, but I am not satisfied with my education. Which would be the best school for me to join? I understand there are free schools in different parts of the country. I would like to have your advice as to which is the best one for obtaining a technical education, including algebra and kindred studies. Please state where the schools are located. *A.*—If you have the ability to learn and sufficient perseverance, you will obtain as good an education in one school as in another, at least in those branches which they undertake to teach. We should, therefore, advise you to enter a school which is nearest to your home. There are two technical institutions in your State—the Missouri School of Mines, at Rolla, and the Mo. Washington University, at St. Louis. Write to either of these, and you will undoubtedly learn ot the right course for you to pursue.

(427) C. H. R., Danbury, Conn., writes: I have a house which I supply with water from a well at a distance of 800 feet from it. The level of the water above the house is 60 feet. I use a 1¼ inch pipe for conducting the water from the well. This works for several days at a time all right, and then stops. I cannot account for this, can you? The man who did the plumbing cannot. *A.*—Your pipe which conducts the water from the well to the house is nothing more or less than a siphon. These frequently give trouble by the collection of air in the pipe, which we believe is the cause of the trouble in your case We also notice in your sketch that there are sharp bends or elbows at each end of the pipe; these also tend to interfere with the satisfactory working of a siphon. Replace these by easy bends, and you may obtain better results. Probably the best way will be to enter the pipe at the side of the well, and at the same distance above the bottom of the well as that to which the present pipe extends.

(428) S. E. F., Bryan, O., writes: A pipe 10 inches in diameter and 2,000 feet long and making an angle of 45 degrees with the horizon is subjected to a pressure of 100 pounds per square inch at its upper end. Will the pressure be the same at its lower end; if not, what would be the difference? *A.*—The pressure at the bottom of the pipe is greater than at the top; the difference is due to the weight of the water. To find this difference, multiply the vertical distance from the lower end of the pipe to its upper end by the weight of a column of water 1 foot high and 1 inch square. The result will be the pressure, due to the weight of the water, at the bottom of the pipe. The vertical height above referred to is $2,000 \times .707 = 1,414$ feet; the weight of a column of water 1 foot high and 1 inch square is .434 of a pound, hence the pressure due to the weight of the water at the bottom of the pipe, will be $1,414 \times .434 = 613.676$ pounds, or a total pressure of $613.676 + 100 = 713.676$ pounds per square inch. This, of course, applies only when there is no flow of water in the pipe.

(429) Cog, Denver, Colo., writes: I am laying a quantity of cast-iron water pipe, 12 inches to 30 inches diameter, on a surface of flat coarse gravel. The intention is to fill the flat to the depth of about 5 feet with cinders from bituminous coal. Will this give trouble by causing the pipe to corrode? *A.*—We should not use these pipes without dipping them in coal pitch varnish, otherwise the pipes may give considerable trouble in time. Of course, before the varnish is applied, the pipes must be thoroughly dressed and made clean, free from the earth and sand which clings to the iron in the molds, hard brushes to be used in finishing the process to remove the loose dust. Great care must also be taken to have the pipes entirely free from rust when the varnish is applied. If the pipe cannot be dipped immediately after being cleansed, the surface should be oiled with linseed oil to preserve it until it is ready to be dipped. Every pipe must attain a temperature of 300 degrees Fahr. before it is removed from the vessel of hot pitch. It may be slowly removed and laid upon skids to drip. All pipes 20 inches in diameter and over will require to remain at least 30 minutes to attain this temperature.

(430) L. F. A., Phenix, R. I., writes: In your issue of August 3, in answer to Question 385 you give $36\frac{1}{3}$ horse-power that the belt will transmit. Please give your method of computing this power of transmission. Also give the power a single belt will transmit. If you have answered this before, please state in what number. I find many rules, but when applied no two bring the same result. *A.*—In computing the power which single belts can transmit, we assume that the safe working tension of a belt of the average thickness, $\frac{3}{16}$ inch, is 45 pounds per inch of width, which is equal to a velocity of $\frac{33,000}{45 \times 12} = 61.11$ square feet per minute per horse-power. For simplicity we take 60 square feet per horse power; this is an easy rule to remember, as it gives a velocity of one square foot per second per horse power. Let C = circumference in inches of pulley; R = revolutions per minute; W = width of belt in inches; H = horse-power that can be transmitted by the belt. We then have according to the above data,

$$H = \frac{C \times R \times W}{144 \times 60} = \frac{C \times R \times W}{8,640}.$$

This rule can be simplified by substituting the diameter D in inches for the circumference C. Remembering that C is equal to $D \times 3.1416$, we have,

$$H = \frac{D \times 3.1416 \times R \times W}{8,640} = \frac{D \times R \times W}{2,750},$$

this is the formula we use for single belts. The transmitting efficiency of double belts of the average thickness is to that of single belts as 10 is to 7; therefore, for double belts the formula will be,

$$H = \frac{D \times R \times W}{1,925}.$$

The foregoing formulas apply to open belts working on pulleys of equal diameter. The last formula is the one we have used for computing the power transmitted by the belt referred to; although the pulleys on which this belt runs are not of equal diameter, the difference in the arcs of contact is but small, and was therefore neglected. If, however, the difference of the arcs of contact is great, it cannot be neglected, and the divisors in the foregoing formulas must be changed according to the following table:

When the arc of contact on the smaller pulley is equal to

	Single Belts.	Double Belts.
¼ of the circumference, use	6,080	4,250
5/16 " " " "	4,750	3,310
⅜ " " " "	4,400	3,080
⅜ " " " "	3,850	2,700
½ " " " "	3,410	2,390
9/16 " " " "	3,220	2,250
⅝ to ¾ " "	2,750	1,925

The results obtained by these rules may be regarded as safe and reliable for belts running under ordinary conditions, but there are circumstances for which the foregoing rules must be modified; for instance, belts for machines which are frequently stopped and started, and shifting belts, must be wider, to stand the wear and tear, and to overcome the starting friction, than belts which run steadily and uninterruptedly.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears. Lex'n, Mass., & Phila., Pa. See p. 12.

Ideal Drawing Stands. M. C. Hammett, Troy, N Y.

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Drill Presses, with Tapping Attachments.
Gould & Eberhardt, Newark, N. J.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N. Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

For Cypress Tanks and Vats, address W. E. Caldwell Co., Floyd and Main Streets, Louisville, Ky.

$5 gauge shows speed and all changes of eng's, mach'y, etc. C.T. McL. & Co., 120 Fulton St., Boston.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

"Shapers (Double Triple Quick Stroke")
Trade Mark.
Gould & Eberhardt, Newark, N. J.

Gear and Rack Cutting, Drawings for Bevel & Miter Gears, Cutters for Spur & Bevel Gears Milling Cutt's, Vert'l Mill'g Mach's. R. M. Clough, Tolland, Ct.

"Pumping Machinery." New book, 450 pp, 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton Avenue, Philadelphia, Pa.

12-inch breech-loading rifled mortar & mounting, w'ght 118,000 lbs., front Gov't B'ld'g, World's Fair; des'n on applica'n. Builders Iron F'dry, Prov., R. I.

Gear Cutters, Auto. Specially adapted for Motor Gears and all other style Gears
Gould & Eberhardt, Newark, N. J.

Patent Soliciting of High Class.
D. Walter Brown, Counsel in Patent Cases,
111 Broadway, New York.
Send for Brief History of Patent Legislation.

De Lamater Screw Propeller Wheel, made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

Things to See at the Fair—Continued.*

Rambling around the south end of the grounds back of Machinery Hall, one will find the out door machinery and the saw-mills, which so well exemplify what we so pride ourselves about—"bigness," "quantity," "get there," and "American push."

This beating the world, each other, and everybody else, is a national characteristic born in us, and shows itself in the children. Watch the young girls in any of our cities jumping the rope. What the rope is, whether a rope, a twisted string, or a bed cord, is a matter of indifference, but how many times without a skip and how long it can be kept up is the aim, a hundred times the goal. In Paris how different. Nothing but a twisted or braided cord in colors with tassels will do, and how prettily they can do it is the aim. It is this same inborn spirit, largely developed in the saw-mill men, that attracted my attention. Not how good we can make the lumber or how little we waste, but how many thousand feet in a day. Ten-eighths of an inch out of the log to get seven eighths of planed lumber, or a loss of 30 per cent. has been the practice, when it would seem that to save one-eighth out of that, or 10 per cent., would be worth striving for. As the price of pattern lumber has gone up from sixteen dollars to sixty dollars a thousand, of black walnut from twenty to one hundred dollars, and other woods in like proportions, within my industrial life, the time is likely to come when some one will discover that this saving will be worth looking after, even if one has no scruples against such a reckless waste of the gifts of nature.

I have been led to make these observations after noting that the prominent exhibits show band-saws taking the place of the circular saws, and remarking to the ex-

* By permission

hibitor that there was less waste. "Oh," he said, "we saw more lumber," as if that was the aim and end of the whole business; and I could but wonder if they had ever figured out what a saving of 10 per cent. of the log meant—10 per cent. less to buy, 10 per cent. less to handle, 10 per cent. more in the woods. If to saw it better would raise the price a dollar a thousand, how many less thousand feet would they be able to saw and make the same money? The time will come, I believe, when they will ask that question with an exclamation point. When, too, will some one rig up a mill to "quarter saw" hard wood logs without waste? An easy thing to do, and a trick waiting hard for some one with courage to do it.

One interested in logs, timber and big things will find in the "Big Tree Café," off near the southeast corner of the grounds, one of the sights of the Exhibition. The counter of the place is made of a fir stick 3 feet thick, 3½ high, and 110 feet long, and when he considers that that is equal to sixty-three beams 12″x14″, 15 feet long, he is liable to fancy that it is one of the marvels from the State of Washington.

Following up the wood industries and products, near the Big Tree Café, the Forestry Building will be found, and the exhibits from the foreign countries will show to the average American many specimens which will be a revelation, and the names to him unheard of before. The time will come, and that before pine lumber reaches a much higher figure, when architects will reduce the amount of wood finish in a house, using a little nice wood well finished in place of a wide display around openings of white paint and oak graining. Like all the other buildings, there are wonders in the Forestry Building which will interest all, and adjoining it the Shoe and Leather Building is equally interesting in its wonders, and the belting, perhaps, most so to the machinist. A roll of belting a foot or so wide, and twelve or fifteen feet in diameter attracts attention, although when one comes to think of it, there wasn't much genius required to produce it. In the case of the belts six feet or more wide shown here and running in Machinery Hall, it may be that special skill was called into play in their construction, but one knowing nothing of the business is likely to fancy it more a question of dollars than skill. Unless one has more time than we, he will have to skip many of the minor attractions. We left the southeast region, which in early June was not very inviting, though one need not do what we were compelled to do, pass the Krupp exhibit, which was then incomplete and not open to the public. One of the facts that may not reach the ear of the visitor is that one of the smaller guns has thrown a shot fourteen miles, and that if Mount Blanc had been between the gun and where the shot landed it would have made no difference, the shot would have gone over the top. This gun, I suppose, is no larger or better than our own, and likely our 13″ cannon would do the same, though I have not heard of its doing that, but the 16½″ gun is way beyond the largest of our own, and I fancy the long hollow steamboat shaft is beyond our facilities, and, likely, beyond our wants.

What a glory on modern mechanics these great guns, armor and implements of war confer; what a sad commentary on modern civilization. Think that nations, civilized nations, Christian nations, rulers and followers should clamor for, glory in, and pay for these modern engines for the destruction of human life. "In time of peace, prepare for war," the worst sentiment ever framed in the English language, has one redeeming feature; while the preparation goes on, the money goes into the workmen's hands, and the experience obtained may be turned to peaceful pursuits.

Near Krupp's Building and the lake is located the reproduction of the old Spanish Monastery, true to size, and containing all that could be obtained of all the relics connected with the life of Columbus; all historical, interesting and instructive, but the furthest removed from modern mechanics of all things to be seen. Parts of the old boats, an old cannon, pictures, writings, and other relics. Near by are the reproductions of the vessels, as also that of Lief Erricson, and one can take his choice as to whether he pays homage to the Italian, the Norseman or the Cabots. It will make but little difference to either.

Walk along through the Casino, the Peristyle, and the Music Hall, looking back over the basin, and get another view of the grand architectural effect, oblivious, if possible, to the fact that it is all make believe, and that it is all so soon to be swept away.

The Peristyle is in itself a wonderful piece of work. Something like a hundred columns 4 or 5 feet in diameter, and forty or fifty feet high, beautiful in their proportions, set in four lines, carrying a roof wide enough to cover the whole, likely fifty or sixty feet wide by six or eight hundred feet long, with statuary on top, and the whole forming an open screen between the grounds and the lake. Simply a structure for architectural effect. Such things as these must certainly be a surprise and a lesson to those who have never seen the stone originals.

Running out from the Peristyle into the lake is a long pier, and on this the traveling sidewalk run by electricity, and that furnished by engines in Machinery Hall. This traveling sidewalk is a double construction, one walk or platform inside the other, each level with the floor of the pier; the outside one traveling about as fast as one can step on without being upset, and the other at double the speed, and provided with seats upon which, for the sum of five cents, one may experience the novelty of getting around a little easier and cheaper than staying at home.

Returning to the grounds one is at the south end of the Manufacturer's Building; that is the large one of the group, a building very nearly a mile around, and the outside wholly a colonnade. Immense columns and pilasters, and a walk or veranda fifteen or twenty feet wide. Inside, for 150 feet or more, it is two stories high all around, and in the center the great room nearly 400x 1,300 or 1,400 feet. One mistake has been made in limiting the number of entrances, and where there should have been entrances in the corners above all other places, they are filled in with restaurants. Not but what restaurants are good things, but they would have done just as well any where else, and visitors going from one part of the grounds to the other are sure to start to go out of the corner of a building, and finding the road blocked, have half the width of the building to retrace their steps.

Once inside the building, among the thousands of things to see, do not fail to notice in the Spanish section a reproduction of one of the old Mosques; the Italian bronze and marble art work; the French exhibit in full, and to some the religious images may be interesting. There is a perfect reproduction of Peter's statue in St. Peters, Rome—the one where the big toe has been kissed away by devotees. In the German exhibit do not fail to notice the iron gates, and that they are specimens of blacksmith work, also the Nuremburg exhibit, background and all. In the Russian section there are the Firs and Malachite table tops and ornaments that certainly ought to astonish people. Compare these products with the Arizona petrified wood; and they are comparable, except in the finished product.

In the Swiss section, among the other things, there is the best watch ever made in the world. The element of "position," one of the difficulties in making a perfect watch, is overcome in a very ingenius manner. It seems to me that when a person has a chance to see the best of anything of its kind the world has ever produced, that it is best to embrace the opportunity to see it, particularly when the thing is one that thousands of men have been hundreds of years working to accomplish. And yet very few see this watch or pay special attention to it, while there is one of the greatest of crowds in the whole exhibition around the one day's product of the American Watch Company. Simply 2,000 movements of the various kinds manufactured by that company in one day. Meritorious beyond question, but it is not merit but extent of display that draws the crowd. However, so long as I will go in with the rush to see the Kohinoor, or to hear Patti, but not to see a dog fight, it is no reason why others should not do differently.

John E. Sweet.

Letters from Chip.

BIOLOGY IN MACHINE DESIGN.

Mr. Editor: Birchall has a new hobby—this time it is legs. When I dropped in on him recently he was very enthusiastic over a new machine he had just built and called my particular attention to the supporting base, which I admitted was of very pleasing design.

It appears that he was making this machine—a nipple threader or something of that sort—for a plumber by the name of Talbot, who had some ideas as to how such a machine ought to be made. Birchall got a hold of the idea Talbot wanted worked out, and gave his draftsman some rough sketches from which to work up a drawing of the general arrangement, suggesting at the same time that the working parts be mounted on a flat plate which should be raised to the proper height from the floor by cast legs of the usual lathe pattern; the spindle could then be supported by a pair of pedestals resting on this plate, which would also serve as a base for the attachment of other parts.

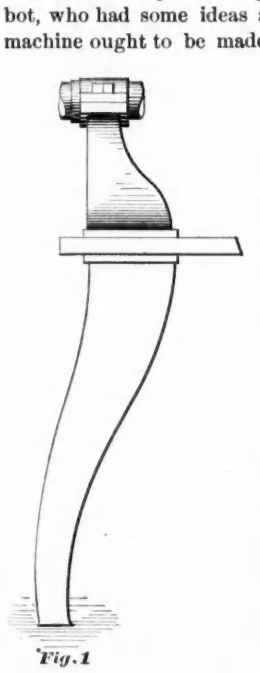

Fig. 1

When Thomson was sketching in the legs Talbot came in the shop to see how things were getting along, and he was shown the penciled drawing. It struck Talbot as somewhat odd, when he saw the side view as represented in Fig. 1, that the part of the leg which rested on the floor should be so much smaller than the upper part where it joined the flat plate, while, on the other hand, the base of the pedestal where it rested on the plate was larger than the upper part—exactly the reverse of the lower support.

"Why," asked Talbot, "should these two pieces—both used for the same purpose, that of a support—why should these two supports have such a totally different shape? If the pedestal with a generous base and tapering lines towards the bearing is correct in design why should this same principle not be employed in the design of the leg support?"

Birchall argued the case with him for some time, but as he wanted to suit his customer he finally said that of course it was not necessary to have that kind of a base; he only had Thomson arrange it that way as a matter of convenience in building the machine, and then, besides, he thought he could use a leg pattern which he had on hand and thus save expense; but as Talbot had said he didn't care if the machine did cost more as long as it was built according to his ideas, why, of course, they could alter the plan and throw out the leg arrangement altogether.

* * * * * * *

As a result the flat plate and lathe leg were discarded, instead of which there was substituted a column support which was very neat, stiff and heavy, resembling in its general appearance an oblong pedestal wider at the base than at the top in both the front and end views. Fig. 2 shows the base as I sketched it on the setting up floor.

In talking over the subject of supports Birchall said that he had been in the machine business for thirty-five years and had seen a good deal of machinery, but it never occurred to him until pointed out by that plumber that the lathe leg to which we have become so accustomed could, with a little change in regard to spread, be used to advantage upside down, and the more he thought about the thing the more it seemed to him that the lathe leg support was not the best construction for the purpose.

I ventured to suggest that the designer of the lathe leg was simply copying nature, and showed him the similarity between the leg of a horse and a well-shaped lathe leg, both sketched from the side. "Yes," said Birchall, "I made a similar remark to my customer, but he did not think I had strengthened my cause any. He said, 'You machine men try to imitate nature in your designs, but you don't copy the right thing. Now take, for example, your horse; the legs are strong and well built and of symmetrical proportions, there are no sharp corners, and where they join the body they are wider than at the knee and foot; if I were to get up an automaton to walk or move as a horse does, I should expect to copy his anatomy in this respect, and would go a little farther and put joints in the legs. As an automatic horse it might be a success, but as a useful means of locomotion it would be on a par with the winged flying machines in which the inventor copies the motions of a goose.

" 'On the other hand if the machine were intended to be firm and rigid I should want a base more like a tree trunk—big at the bottom. I suppose one reason why you use the lathe leg smaller at the bottom is on account of assumed irregularities in the floor, but here the floor is at fault and should be made to suit the machinery it is to carry—not the machinery to suit the floor.

" 'Now I'm not much of a mechanic, and have not been around machine shops very much; perhaps if I got around more I would become used to these things as you have, and would think they were all right, but as it is I think you could get more and better work out of some of your machines if they were not so weak in the knees.' "

* * * * * * *

"Well," Birchall continued, "I thought there was some truth in all of this talk and since my attention was first called to it I notice that the lathe leg style of machine support is being replaced by a column, or base support, and that in a great many cases where legs are used the design is such that the wider part is at the bottom—not at the top as formerly. Look at the Putnam lathe leg, for instance; is anything neater than this, and does it not give an appearance of rigidity to the whole structure?

"Then there is the cabinet leg of other makers which also fills another office—that of tool or scrap cupboard.

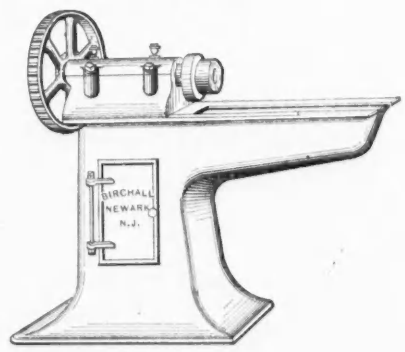

Fig. 2

"Sometimes the cabinet leg is found under the headstock of a heavy lathe, and a light frame leg is used at the other end of the bed, reminding one of an elephant with the hind legs of a horse; these machines are in a transition state and will eventually possess two cabinets according to the laws of evolution.

"In certain other machines the cabinet is modified and forms a substantial base or column as seen in the various modern forms of shaper, grinding, milling and other tools.

It used to be the style to set small milling machines, tapping machines, grinders and a variety of special tools on short legs screwed to a flat plate which was supported by a form of leg whose cross-section was the L-shape of the familiar lathe leg or its section was elliptical, star, I, T, or some modification of these.

"The short legs are now seldom used except in screw machines and we find the same tools mounted on columns or other box base.

"I never used to think much about the form of tools so long as they would work, but I can see there is a good deal in it. In

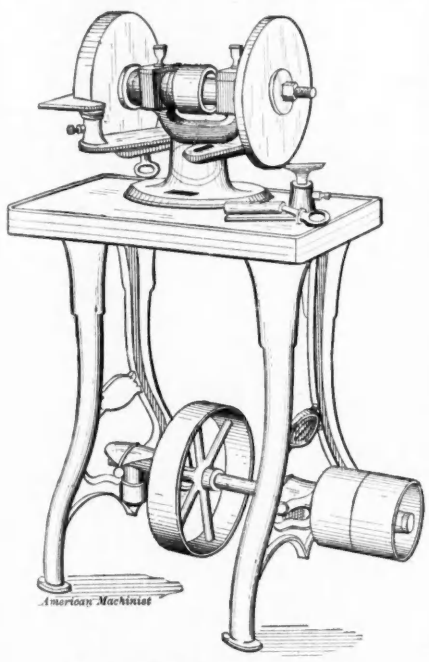

Fig. 3. Emery Grinder, 1878.

these days of close competition more and better work is demanded of a given tool, heavier machines are built accordingly, and tool builders are awake to the necessity of providing substantial supports for their machines."

* * * * * * *

Is there a fashion, Mr. Editor, in machine tools as in spring bonnets, or must we assume that the doctrine of the survival of the fittest obtains here?

I have been looking up the matter since Birchall's talk, and have added some pages of very interesting and instructive cuts to my scrap book, which, though not completely showing the process of evolution, they do show some changes that have occurred during the last fifteen years. The architectural style of design with its fluted columns, beads and fancy scrolls has almost

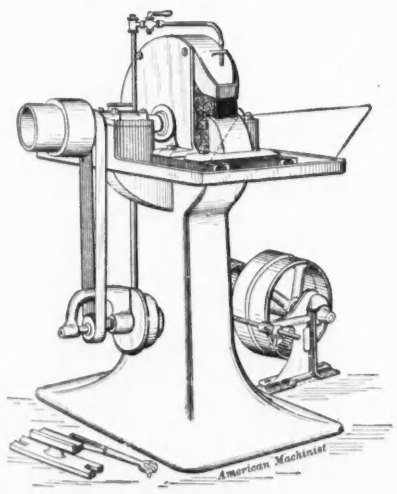

Fig. 4. Emery Grinder, 1893.

entirely disappeared; the weight of the machines has been increased from 25 to 50 per cent., and the style of support has undergone a radical change.

A good point obtained by the use of the column support is that the greater amount of metal in the base acts as an absorbent to the vibrations set up in the machine—in high-speed machinery this is an especial advantage. Compare, for instance, the emery grinders represented in Figs. 3 and 4; the design of the latter is not only much neater and more compact, but there is no comparison in regard to the stiffness of the machines, nor the work which each could produce.

Mere weight in the frame will not secure stiffness, but if the metal be properly disposed to resist the strains in a given machine, an increase in weight will secure stiffness if the shafts and working parts are of ample size.

* * * * * * *

Compactness and convenience are features generally found in the same machine, but not always. Who of us has not had to walk around a planer and climb over a pile of castings in order to raise the cross-slide, because the gear shaft was not provided with a wrench or handle at each end? And how convenient it would often be if we only had a handle on both ends of the horizontal feed-screw of a planer?

In selecting a tool the pertinent question to the manufacturer is not which of the two machines will take the larger chip, nor which is the cheaper, but which will enable a man to turn out the greater amount of work per day?

Convenience in changing work and speeds, location of working handles, rate and reliability of feed, ease and rapidity in changing and setting tools, convenient and efficient means of lubrication, size and accuracy of bearing surfaces; these are points which make one machine superior to another, and when these features exist along with stiffness and ample belt surface we have what may be called a good tool. CHIP.

The Antwerp Exhibition.

We are in receipt of a copy of the "General Programme" of the Antwerp International Exhibition of 1894, which is to be held in Antwerp, Belgium, beginning May 5, and continuing six months. It is under the high patronage of his Majesty the King of the Belgians, and the honorary president is, "his Royal Highness, the Count of Flanders."

The main buildings of this exhibition will cover about 120,000 square yards of ground, and will be constructed of iron and steel, roofed with zinc.

In the Halls of Machinery and Electricity a charge will be made for space at the rate of 60 francs per square meter, this charge being reduced one-half in the case of machines supplied with power and working at least five hours daily. Full information regarding the exhibition may be obtained by those who may exhibit by addressing the Antwerp Exhibition, 9 rue Gerard, Antwerp, Belgium.

It is reported that the steamship "Rappahannock," one of several steamers built for the Chesapeake & Ohio Steamship Co., was recently launched from the yards of Messrs. Alexander Stephen & Sons, Clyde. This is the first one of three vessels which this firm are building for the above-named steamship company; another three steamships are being built by Messrs. Furness, Withy & Co., Limited, of West Hartlepool. These vessels are intended for service between England and Newport News, Va.

The "Rappahannock" is built of steel, 370 feet between perpendiculars, 44 feet beam, and 31½ feet deep. The cylinders of her triple-expansion engine are 28, 46 and 75 inches diameter by 54 inches stroke, and will run with a steam pressure of 165 pounds. She is mainly intended for carrying cattle and cargo, and there are spare rooms of a comfortable kind for a limited number of first-class passengers. Her carrying capacity is from 5,000 to 6,000 tons. The whole of the accomodation is heated by steam; the vessel is lighted throughout by electricity, and the ventilation is said to be excellent.

A very interesting series of experiments with the Sims-Edison electric torpedo have lately taken place under a special commission appointed by the French Minister of Marine. On the 12th inst. three buoys were moored out at sea, at some distance from the Caraque Battery, and the electrical engineer was requested to steer a torpedo round each buoy in succession, to test its electrical steering capacity. The sea being rough a successful result was unlooked for; but on the order being given to start it was at once seen that the weapon was under complete control, the torpedo passing round each buoy in succession, stopping, starting and returning to the point of departure at the will of the operator. The roughness of the sea appeared to have no effect upon it, the speed attained being 11 knots, and the cable paid out 1½ kiloms. On the 19th a special trial of speed was made, the sea being high, when two miles were covered by the torpedo at the rate of 18½ miles an hour. With such present possibilities, what may not be urged as capable of accomplishment in the future?—*The Engineer* (London).

MANUFACTURES.

T. C. Robertson will establish a print works plant at Pickens, S. C.

C. Ehrhardt will establish a cotton manufactory at Ehrhardt, S. C.

The new Enterprise Hosiery Mill has been started at Elizabethville, Pa.

The Salem (N. J.) Knitting-mills have again been placed in running order.

M. G Shaw & Sons may establish a sash and blind manufactory at Bath, Me.

The Consumers' Paper Co. is building a straw-board mill at Westside, Ind.

C. P. Maxwell, Lisbon Falls, Me., is erecting an addition to his iron foundry.

The Toronto Railway Company will establish a foundry plant at Frederick, Ont.

A 170x50 foot addition is being built at the Ontario Bolt and Forge Works at Toronto.

Paterson & Corbin will further enlarge their car manufactory at St. Catherines, Ont.

The Orion Knitting-mills, of Kinston, N. C., will put in additional knitting machinery.

The Leibach Woolen Co., of Lycoming, Pa., has been formed, with a capital of $30,000.

The Quabog Hosiery Co. has procured land at Westfield, Mass., and will shortly build.

The Snyder & Son's Co., of Piqua, O., will build a large saw-mill plant at Meridian, Miss.

There is talk of a gravity system of water-works being put in operation at Angelica, N. Y.

A large paper-making plant will be erected by Remington Brothers, of Watertown, N. Y.

The Naubuc paper mill, recently destroyed by fire at Waterbury, Conn, will be rebuilt at once.

A new straw manufacturing concern is to be started at Stamford, Conn., by T. B. Smart & Co.

It is reported that the Arlington Mills Mfg. Co. will build a $12,000 manufactory at Wilmington, Del.

The Holly Manufacturing Company, at Lockport, N. Y., is greatly enlarging its plant in that city.

It is said that a six story addition, 40x60 feet, is being built by the North Galveston (Tex.) Hosiery Mill.

The citizens of Andover, N. Y, have to build a system of water-works at a cost of from $15,000 to $20,000.

The Macon & Northern Railroad Co. has made necessary repairs to its car and machine shops at Macon, Ga.

D. Willing will immediately rebuild his wood-working establishment, recently burned, at Morristown, Tenn.

The contract has been let for building the Hogan Paper-mill at Cedarville, O. The main building is to be 300x60 feet.

The International Kier Mfg. Co. has been formed to dye and bleach fabrics at Paterson, N. J.; capital, $2,000,000.

Stevenson & Co., stove manufacturers, will build a large foundry at their plant on Second street, Philadelphia, Pa.

J. H. McEwen & Co., Ridgway, Pa., are moving into their new shops, which are of the most modern construction.

At Heflin, Ala., a company has been formed to manufacture cotton gins, operate foundry and machine shop, etc.

The cotton factory buildings at Talladega, Ala., are being put up very rapidly, and will be completed by September 15.

The Ajax Iron Works, Corry, Pa., will put upon the market a new design of hot-air furnaces, both portable and brick settings.

The Waterloo (Ont.) Woolen Co. are making additions to the plant, thereby furnishing employment for 75 or 80 additional hands.

It is reported that the Boonton (N. J.) Tool Co. will remove to Utica, N. Y., and that its plant there will be in operation by October 1.

The directors of the Eufaula (Ala.) Cotton-mills have increased the company's capital stock from $100,000 to $150,000, and will add new machinery.

A $50 000 stock company has been formed to erect a knitting-mill at Enterprise, Miss. Contract for buildings has been let; will employ 175 hands.

A. D. Clark, W. H. Clark, Joseph Streiffus and others, all of Findlay, O., have incorporated the West Virginia Glass Company, of Wellsburg, W. Va.

The Woonsocket (R. I.) Electric Machine and Power Co. is to erect a brick structure in a short time. The building will be 143x35 feet and 29 feet high.

It is reported that the Albany (N. Y.) Railway Company will increase its capital to $1,500,000, and introduce an electric system of propulsion for its cars.

The building for the new Mooresville (N. C.) cotton mill is nearly completed, and the company expects part of the machinery to arrive next month.

The Diamond Car Coupler Co., of Chicago, Ill., has organized with capital, $500,000 Incorporators, John B. Leguard, Fred. Stafford and Charles Shreve.

It is announced that a Washington capitalist has paid $5,000 for a site on which he will erect extensive machine works for different purposes in Alexandria, Va.

The Dixon Steam Engine and Machine Co. has been organized at Newburgh with a capital of $300,000. Directors, G. Van Nostrand, C. L. Waring and others.

The Ouachita Manufacturing Co., of Camden Arkansas, has been incorporated with capital $65,000. Incorporators—D. Newton, T. D. Thompson and others.

The Columbia Brass Works, of Erie, Pa., capital stock, $60,000, has been incorporated for the manufacture of metals, etc. T. M. Nagle, of Erie, Pa., is interested.

The Pennsylvania Steel Refining Company, a new organization, has secured possession of the steel works at Greensburg, Pa., and will put the plant in operation shortly.

It is stated that a company which will make plows and cars for the South American trade, has purchased a site for a factory in what is known as New Alexandria, W. Va.

The City Passenger Railway Co., Baltimore, Md., is to build shops for making and repairing its electric and cable cars. The shops will be equipped with all the necessary machinery for the purpose.

W. H. Baldwin, Jr. & Co., it is reported, will erect a flouring-mill on the Little Patuxent river at Savage, Md. Steam and water-power will be provided, and the mill supplied with the most improved machinery.

The Cortland Forging Co., Cortland, N. Y., will erect three new wooden buildings, of two stories, 48x100, 30x36 and 18x40 feet respectively. This will double their capacity. Considerable new machinery will be added, also.

The shops of C., N. Y. & W. R. R., Angelica, N. Y., are running overtime until 10 o'clock P. M. with full number of hands. These shops are very busy rebuilding locomotives, and there is no indications of force being cut down.

The J. A. Fay & Egan Co., of Cincinnati, have just recived an order for a complete outfit of machinery which is to go to Cape Town, South Africa, to equip a furniture factory there. They report a steady increase of foreign business.

A very neat pamphlet entitled, "Electric Lighting and Power," has been issued by the Colburn Electric Mfg. Co., of Fitchburg, Mass. It gives an account with illustrations of the generators and motors made by the company named.

The Salmon Falls (N. H.) cotton-mills are now building a 2-story brick boiler house. The structure is now up to the second story, and will be completed as soon as possible. The boilers have arrived, and are being placed in position.

The directors of the Springfield (Mass.) Street Railway Co. have voted to furnish their own power for the electric cars, and will at once prepare plans and specifications for the power house and let the contract for the building and the engines.

The German-American Emery Wheel Co. has started the manufacture of emery wheels of various kinds at 455 West street, New York City. Some new processes are employed that are claimed to give superior results especially in vulcanized wheels.

The people of Mission City, B. C., are in negotiation with a Scotch manufacturing company, with a view to securing extensive woolen-mills. The mill, it is reported, will be one of the largest on the coast, and employ between 200 and 300 operatives at the start.

The Audible Electric Block Signal Co., of Camden, N. J., has been formed with a capital stock of $1,000,000 for the manufacture and sale of railroad signals. S. T. Kerr, E. H. Cornell, S. Harper, of Philadelphia, and L. Z. Noble, of Camden, are among the stockholders.

The Graham Twist Drill Company, of Detroit, Mich., have issued an attractive and interesting pamphlet entitled, "The Grooved Shank System." It gives a history of the development and introduction of their system of grooved shanks for twist drills, and may be profitably read by all who are interested in the matter of drills and drilling.

The Ideal Machine and Die Works has been organized at Hartford, Conn., to do a fine grade of general machine work. A specialty will be made of furnishing punches and dies, models and gauges for guns, sewing machines and special machinery. The address is P. O. Box 655.

The architect has made the preliminary drawings for a new plant to be built at Toledo, O., for the Vulcan Iron Works. It will comprise a machine shop, two stories, 250x105 feet; engine and boiler house, 30x62 feet. The buildings are all to be of steel construction, with iron truss roofs.

The Duluth Brass Works has just located at West Duluth, Minn., having removed from St. Paul, Minn., where it was known as the St. Paul Brass Works. The Duluth Brass Works occupies a 3-story building, 40x80 feet, and will make a specialty of car brasses and other railroad work.

The Brown Car Coupler Co., of Washington, D. C., has been formed with capital of $100,000 for the sale of car couplers and other railway appliances. The following are interested: Alex. H. Semmes, Felippe A. Broadbeat, Horatio J. Lauck, Albert H. Scott and Philip C. Brown, all of Washington, D. C.

The Berlin Iron Bridge Company, East Berlin, Conn., has received the contract for the new power station for the Atlantic Improvement Company, Astoria, N. Y. There will be two buildings, a boiler house, 62 feet wide and 85 feet long, with a dynamo room 70 feet wide and 130 feet long. The dynamo room is supplied with a traveling crane to be furnished by the same parties.

The Oswego Railway Spring Company's works at Oswego, N. Y., are being enlarged by the addition of a new building, 125x75 feet in size. The new building will be devoted to the manufacture of elliptical springs for locomotives, passenger and street cars, and when the department is completed and in use, about August 20, the entire plant will have a capacity of about thirty tons of springs per day.

The Carolina Cotton-mill Co., at Newton, N. C., is preparing to begin the erection of its factory. The brick is being furnished, and work will soon commence on the building, which is to be 52x240 feet, with lapper and engine room. Mr. J. R. Gaither is president of the company, and Mr. John P. Yount, secretary and treasurer. The capital stock is $50,000. It will begin making yarns, it is expected, on January 1, 1894.

The Syracuse (N. Y.) Silver Metal Company, organized to manufacture compositions of silver and other metals, was incorporated at Albany recently. The capital is $150,000, divided into $25 shares. The directors and subscribers to the capital stock are E. Elmer Keeler, M. D., J. Henry Hallock, M. D., Edward W. Parmelee, Rev. J. Barton French, 400 shares each; Timothy H. Teal, 200 shares, and Thomas H. Gordon, 4,200.

An enlargement to the Corey Needle Works, Manchester, N. H., which will greatly increase their productive capacity, has just been completed. As now arranged 175 hands will be employed when the plant is running at its full capacity. The concern manufactures needles for use in power-knitting machines, and is the largest plant devoted to their manufacture in the world. The plant, when completed, will be valued at about $90,000, and will have a capacity of 2,000,000 needles a month.

Machinists' Supplies and Iron.

New York, August 19, 1893.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $14.50 to $15.00; No. 2, $13.50 to $14.25; Gray Forge, $12.25 to $12.50. Southern brands of good quality are obtainable at $13.75 to $14.50 for No. 1 Foundry; $12 50 to $13 50 for No 2 and $11.75 to $12.50 for Gray Forge.

Antimony—The market is unchanged. We quote L. X., 10.15c. to 10¼c.; Cookson's, 10.25c. to 10½c.; Hallett's, 9.80c. to 9.85c., and U. S. French Star, 10½c.

Copper—The market shows no improvement. Sellers are holding out for 9 70c. for Lake Copper and buyers are offering 9½c. for spot and future delivery, but no business is reported. Casting Copper is held at 9¼c. to 9½c.

Lead—The market is quiet; holders are asking 3.40c. Some business in carloads has been done at 3.35c.

Lard Oil—Prime City is quoted at 65c to 67c.

Spelter—The market is quiet, there are offerings at 3.85c. with the probability that 3.80c. would buy.

Tin—An unexpected advance has taken place with sales of 60 tons September delivery at 18.65c. to 18.75c now held at 18.90c., and 80 tons August at 18 80c. Spot delivery is quoted at 18.75c.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Draftsmen to sell new comb. triangle, pat. protractor, etc. D. J. Kelsey, New Haven, Ct

Wanted—Draftsman and machinist desires a change Address Box 75, American Machinist.

Wanted—Position about Sept. 15, by draftsman, with exp. designing gen. mach y. Box 72, Am Mach.

Wanted—Situation by competent mechanical draftsman. C. D., 1089 Broad St., Newark, N. J.

A1 pattern maker has $3.500 and services to invest in paying business. "Push," Am. Machinist.

Wanted—Position by first class pattern maker. Address P. M., American Machinist.

Young man wants position as assistant draftsman where he can spend part time working in machine shop. Box 83, Roselle, N. J.

Tool maker, steady; 12 years' experience modern machinery and tools, cutters, taps, dies, etc., wants position. Box 71, American Machinist.

Wanted—Position by a first-class draftsman, graduated and with practical exp. in hoisting, steam and general machinery. Box 74, Am. Machinist.

Draftsman (designer), experienced in mach. tools jigs and general machinery, desires position. Address Box 76, care American Machinist.

Wanted—Situation by first-class mechanic, as general foreman or assistant in general machine shop and first-class engine works; thoroughly understands indicator. J. D., Am. Machinist.

Mech. engineer, graduated, German, 27 of age, with several years of shop and drawing room experiences in steam and gas engines, pumps and machine tools, wants position as draftsman; best references. Address Th. W., American Machinist

Wanted—Position as sup't of boiler works or will take job laying out; by a man of large experience in handling a large body of men and turning out A1 work at lowest cost; references A1. Address Boiler Maker, American Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S. M. York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz. Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Drawings and designs of mach'y made at home of an eng'r with various exp. Box 73, Am. Mach.

Thousands of tons of machinery molding sand for sale at Geo. D. Slade's, Waterford, N. Y.

Rubber, metal and composition patterns for carding & grouping; small rubber & metal work to order. John T. Usher, 116 E. 54th St., New York.

Witte Bros., pattern makers; fine work a specialty; orders promptly executed. 23 Carlton Ave., (rear) Brooklyn, N. Y.

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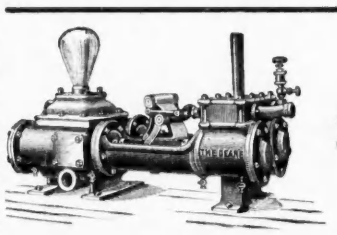

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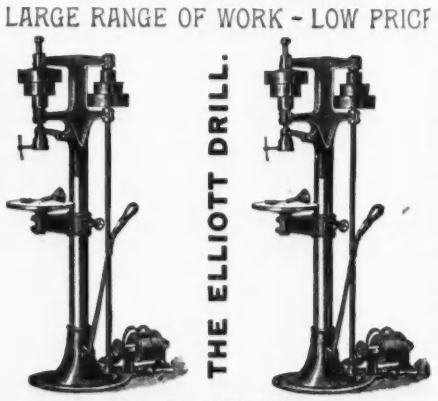

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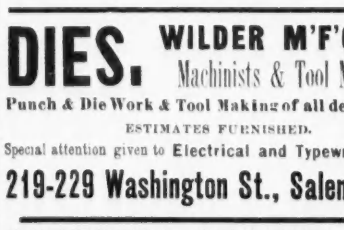

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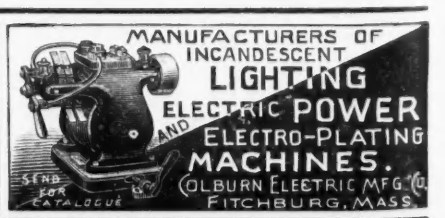

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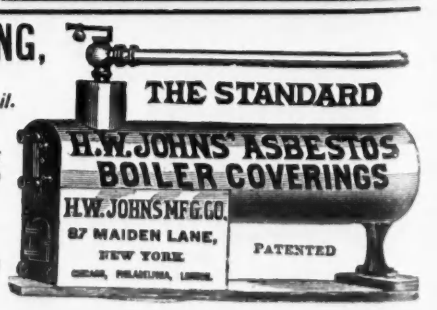

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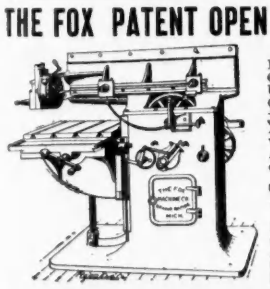

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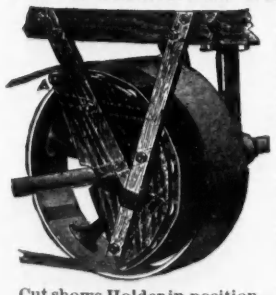

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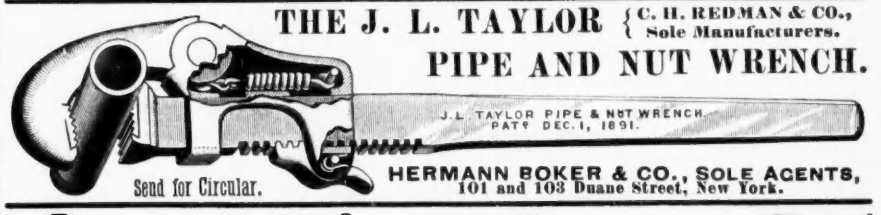

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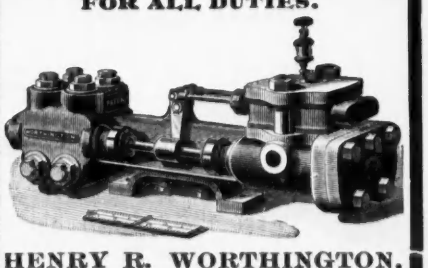

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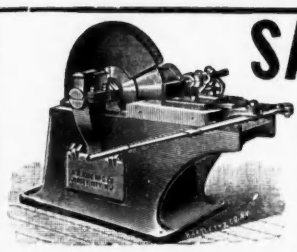

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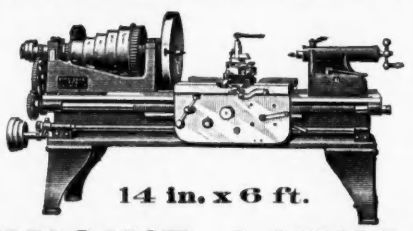

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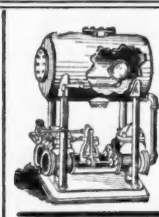

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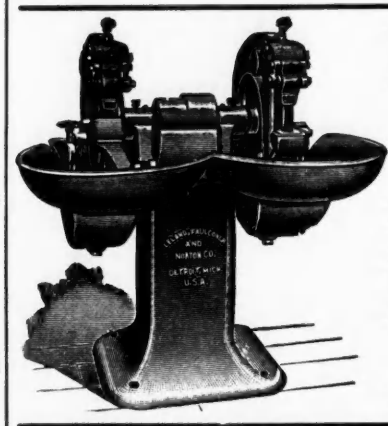

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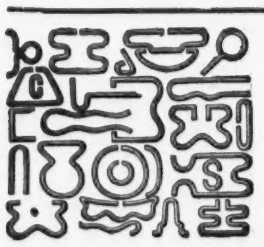

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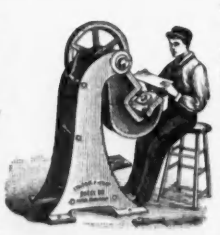

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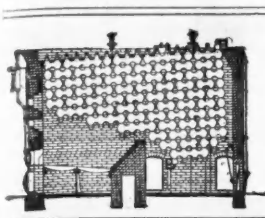

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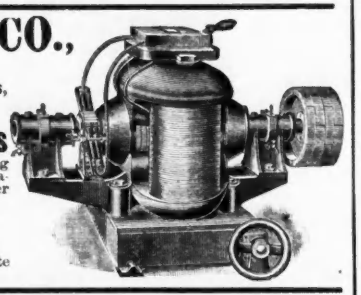

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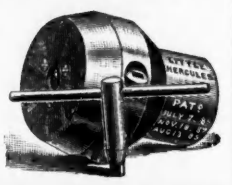

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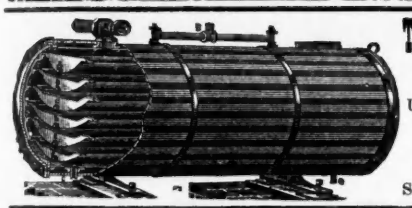

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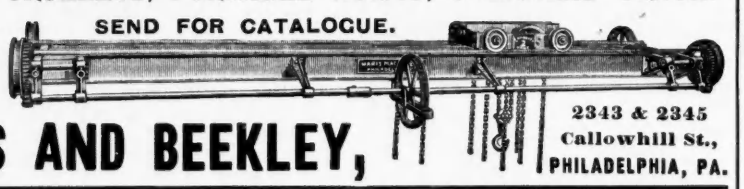

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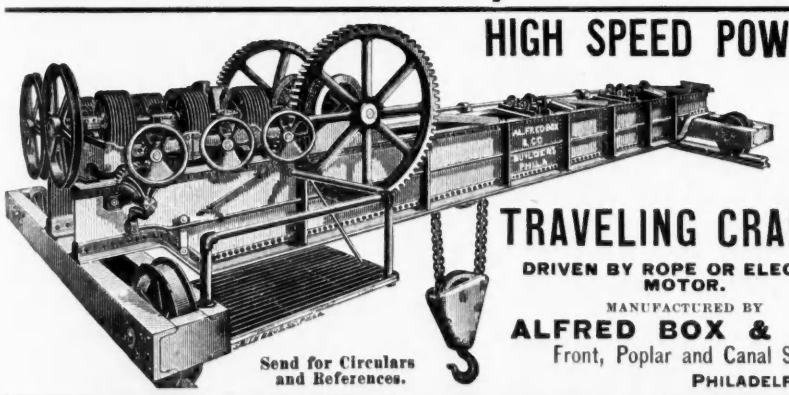

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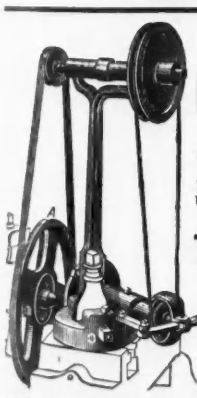

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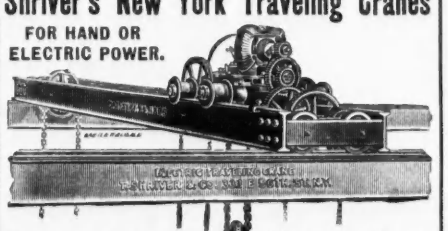

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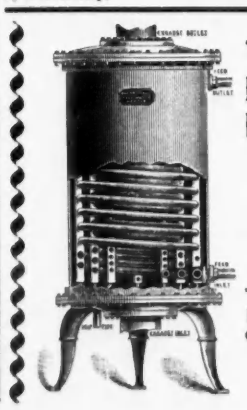

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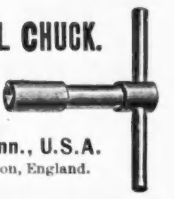

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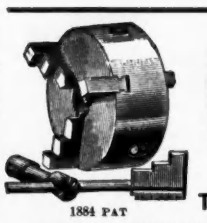
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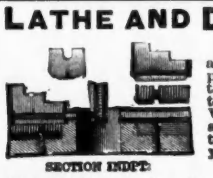
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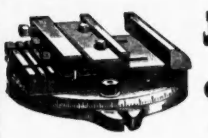

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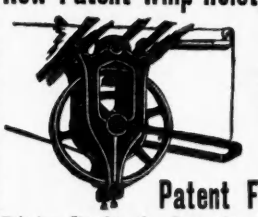

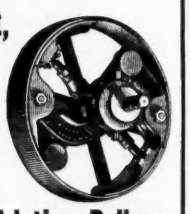

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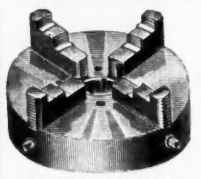

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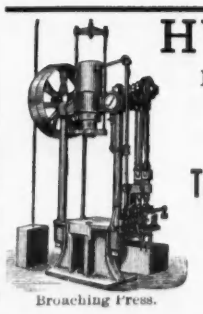
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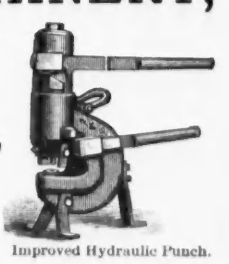
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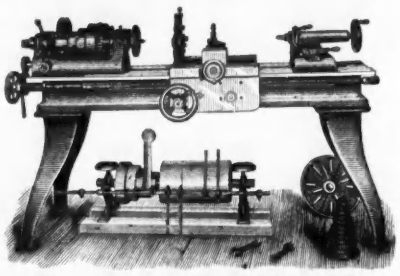

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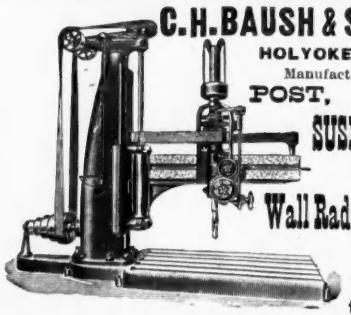

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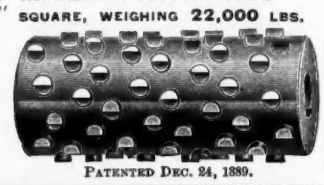

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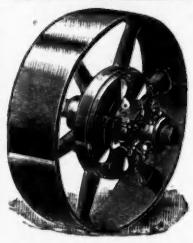

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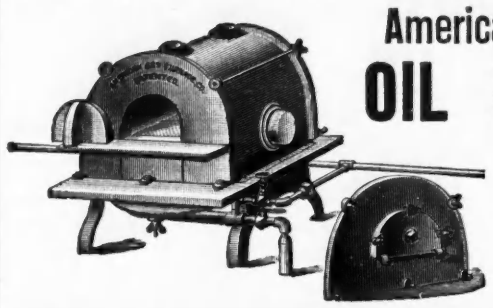

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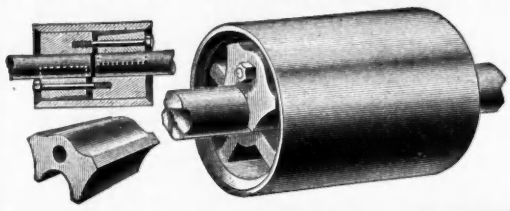

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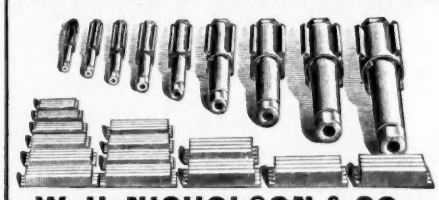

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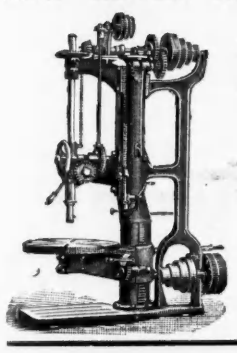

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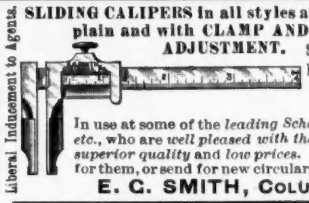

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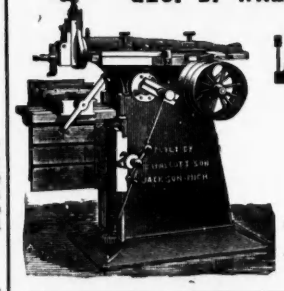

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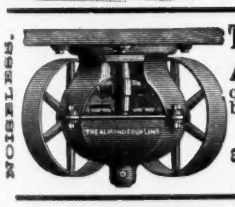

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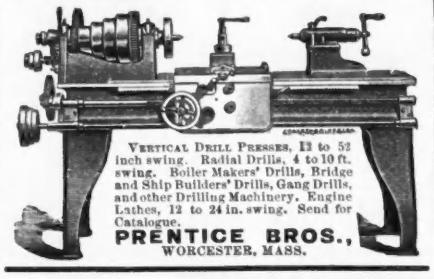

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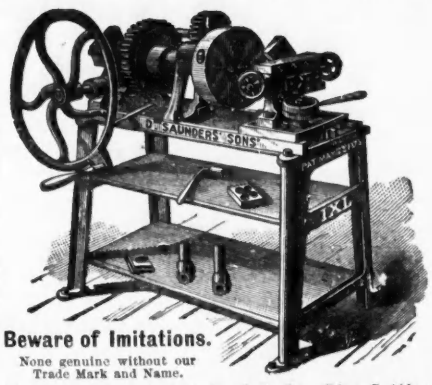

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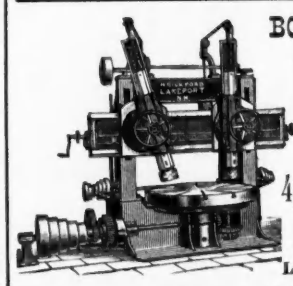

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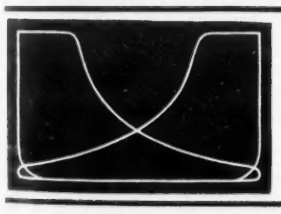

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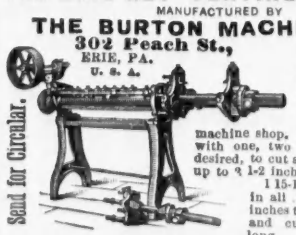

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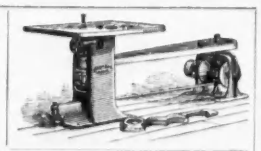

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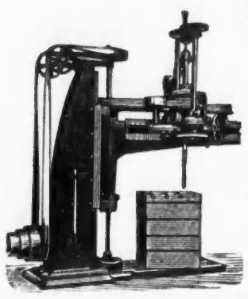

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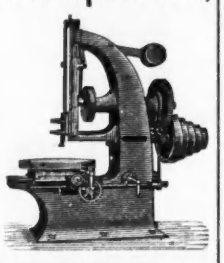

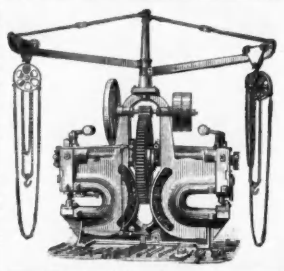

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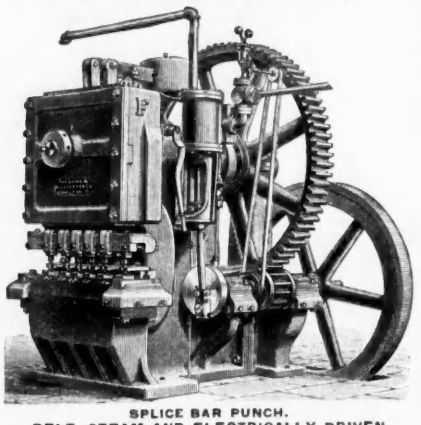

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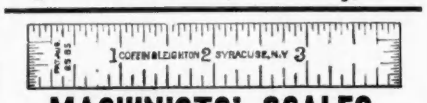

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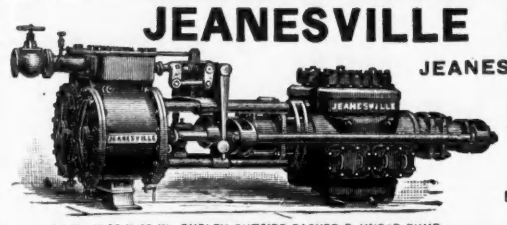

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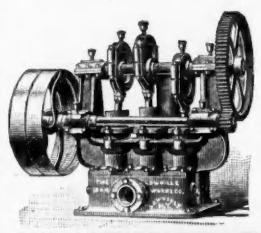

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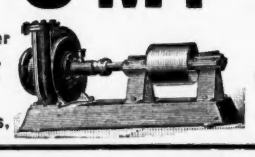

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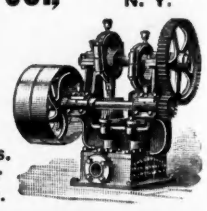

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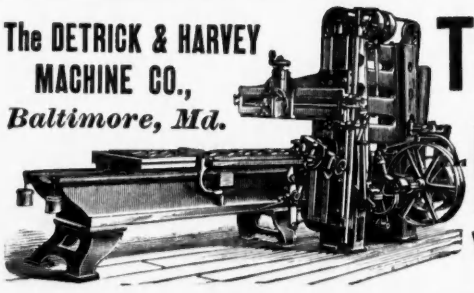

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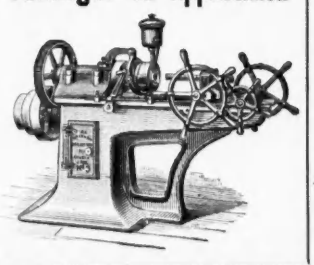

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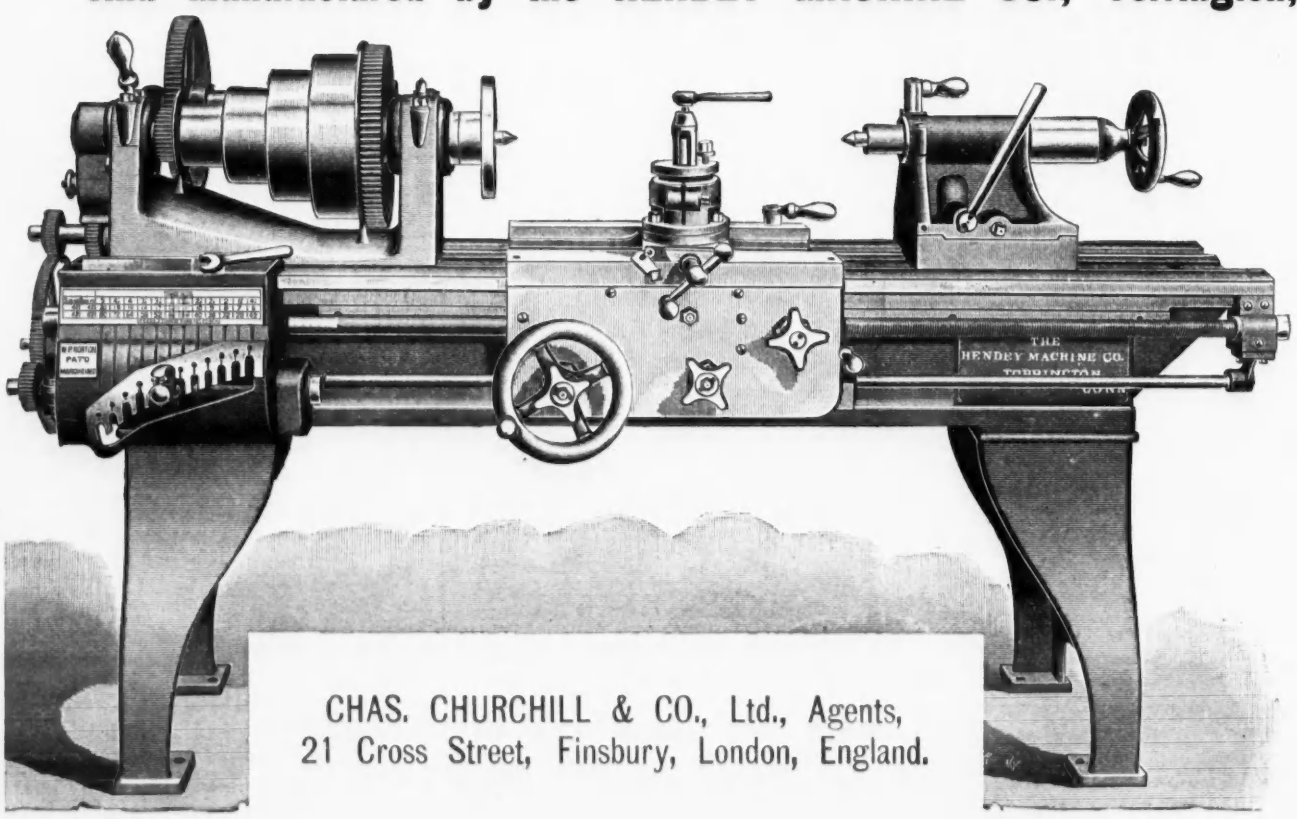

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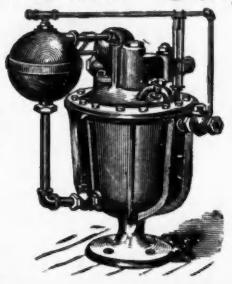

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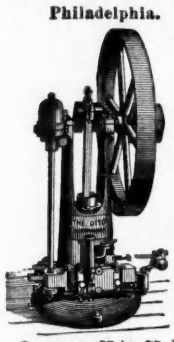

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Consume 25 to 75 Per Cent. Less Gas than ANY other Gas Engine doing the same work.

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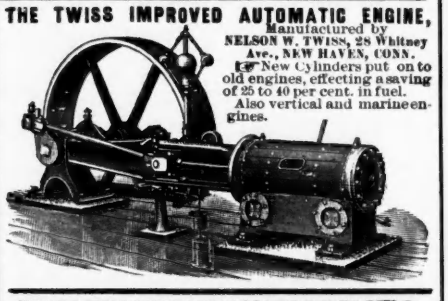

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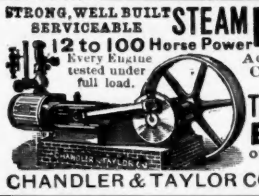

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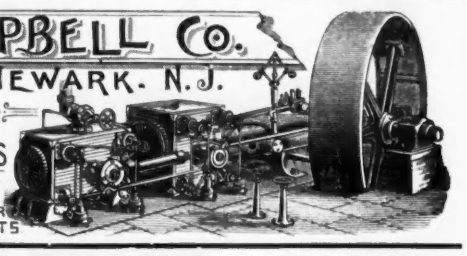

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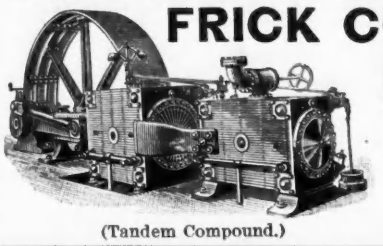

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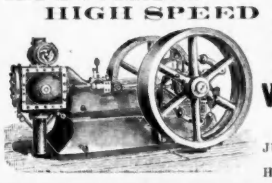

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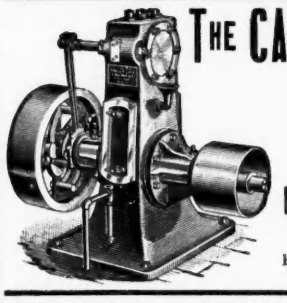

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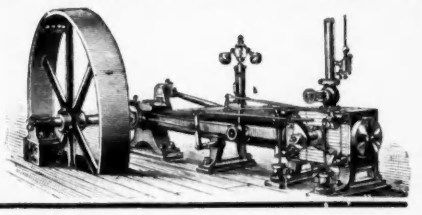

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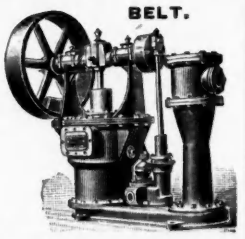

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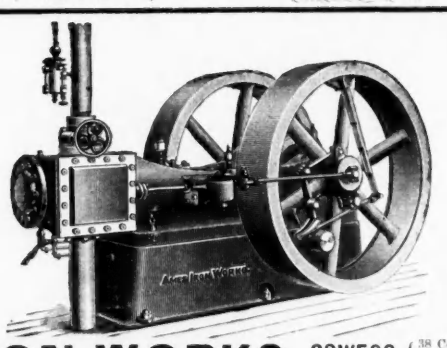

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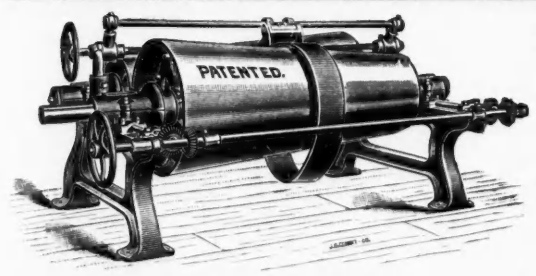

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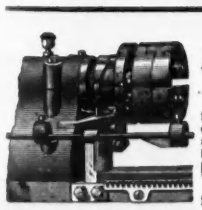

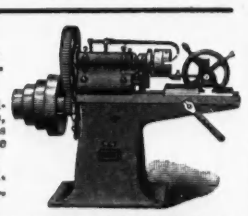

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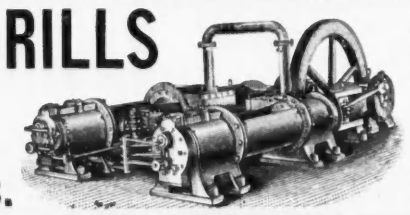

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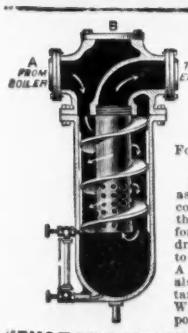

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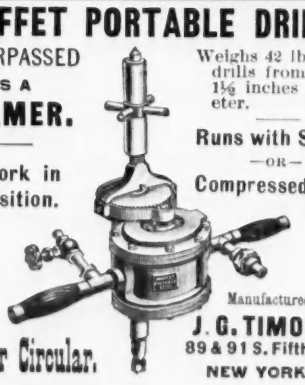

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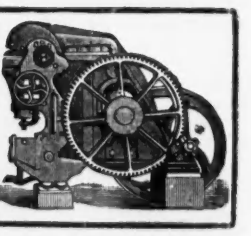

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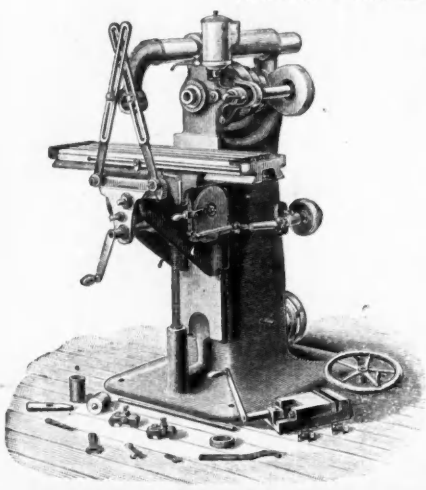

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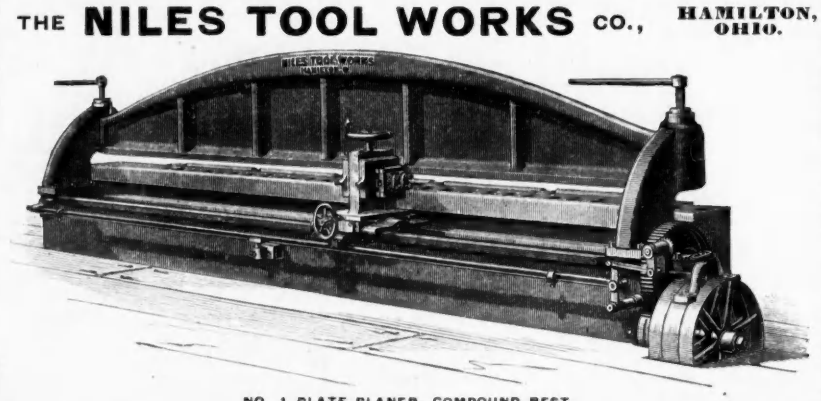

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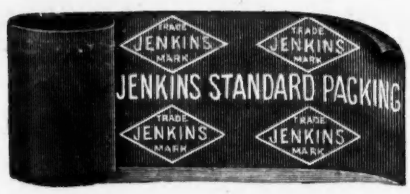

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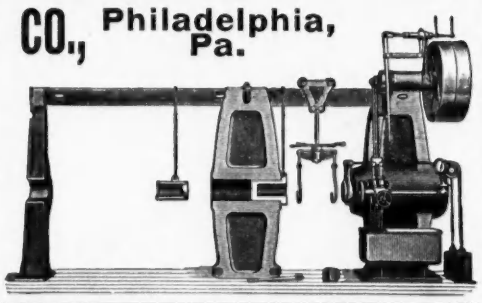

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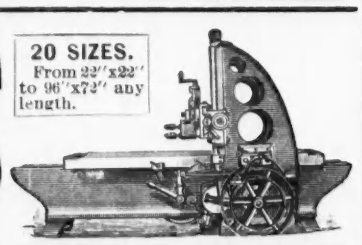

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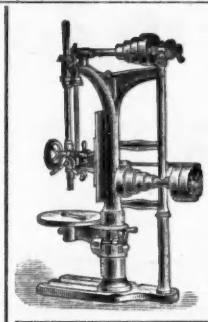

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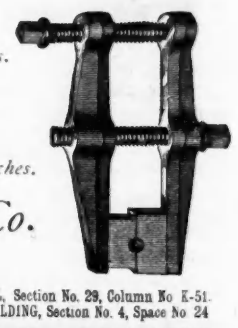

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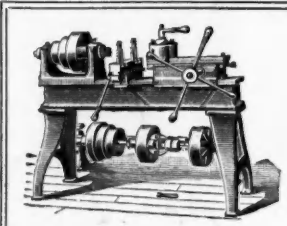

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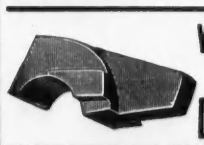

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